SURVEY FOR CONTAMINANTS IN SEDIMENTS AT SELECTED SITES ON THE UPPER MISSISSIPPI RIVER (RM 579 to RM 3) including the Mark Twain National Wildlife Refuge

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Abstract

A regional study of contaminants in sediments at selected locations on the Upper Mississippi River was conducted during the 1989 field season. The study focused primarily on areas within and adjacent to the Mark Twain National Wildlife Refuge (NWR), the Clarence Cannon NWR, other areas of critical importance to migratory waterfowl, and selected industrial sites at various locations throughout the basin. Bed sediments were collected at pre-designated sampling locations. Chemical analysis and fathead minnow bioassays were performed on samples from each location. A comparison of the analyses has confirmed several critical areas of concern or "hot spots", throughout the study area.

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Introduction

The present study was undertaken to develop baseline data on organic and inorganic contaminants in bed sediments, and toxicological potential in bottom sediments at pre-selected areas of concern along the river. The areas of concern consisted primarily of areas adjacent to the Mark Twain NWR, the Clarence Cannon NWR, other areas of critical importance to federal trustee resources, and selected industrial locations. Specific sampling sites were designated within these areas of concern. Samples collected at each site were partitioned into subsamples upon which a battery of analytical tests were performed: bulk sediment chemical analysis of a range of organic and inorganic parameters, 96-hour fathead minnows bioassays, and Microtox analysis. This paper reports the concentrations of organic and inorganic parameters in bed sediments, the results of fathead minnow bioassays, and the results of the Microtox assays for sediment samples at selected locations throughout the Upper Mississippi River basin.

Study Area

The study area for the present study consists of the mainstem Upper Mississippi River and associated backwaters and side channels, from approximately river mile 579 near Dubuque, Iowa, to approximately river mile 3 near Cairo, Illinois (Figure 1). The study area encompasses the six divisions of the Mark Twain National Wildlife Refuge, and the Clarence Cannon NWR. It also encompasses industrial areas near Dubuque, Iowa; Galena, Illinois; Bettendorf, Iowa; Muscatine, Iowa; Burlington, Iowa; Ft. Madison, Iowa; Keokuk, Iowa; Hannibal, Missouri; Alton, Illinois; East St. Louis, Illinois; Crystal City, Missouri; Chester, Illinois; Grand Tower, Illinois; Cape Girardeau, Missouri; and Cairo, Illinois. These sampling areas are listed by river mile in Table 1, and depicted in Appendix A.

The sampling sites were selected based primarily on information within two major reports, "Contaminants Strategy for the Upper Mississippi River" (1988), and "Contaminants Strategy for Southern Illinois" (1989). These were developed by U.S. Fish and Wildlife Service personnel to identify contaminant concerns in the northern portion of the study area, and the southern portion of the study area, respectively. A strategy-based approach to identifying areas of concern with respect to planning basin-wide studies was utilized because of the wide range of potential problems that may be present within a basin. The strategies were developed in such detail that ranking of identified areas of concern resulted. The highest priority areas of concern were then selected for incorporation as sample locations in the present study.

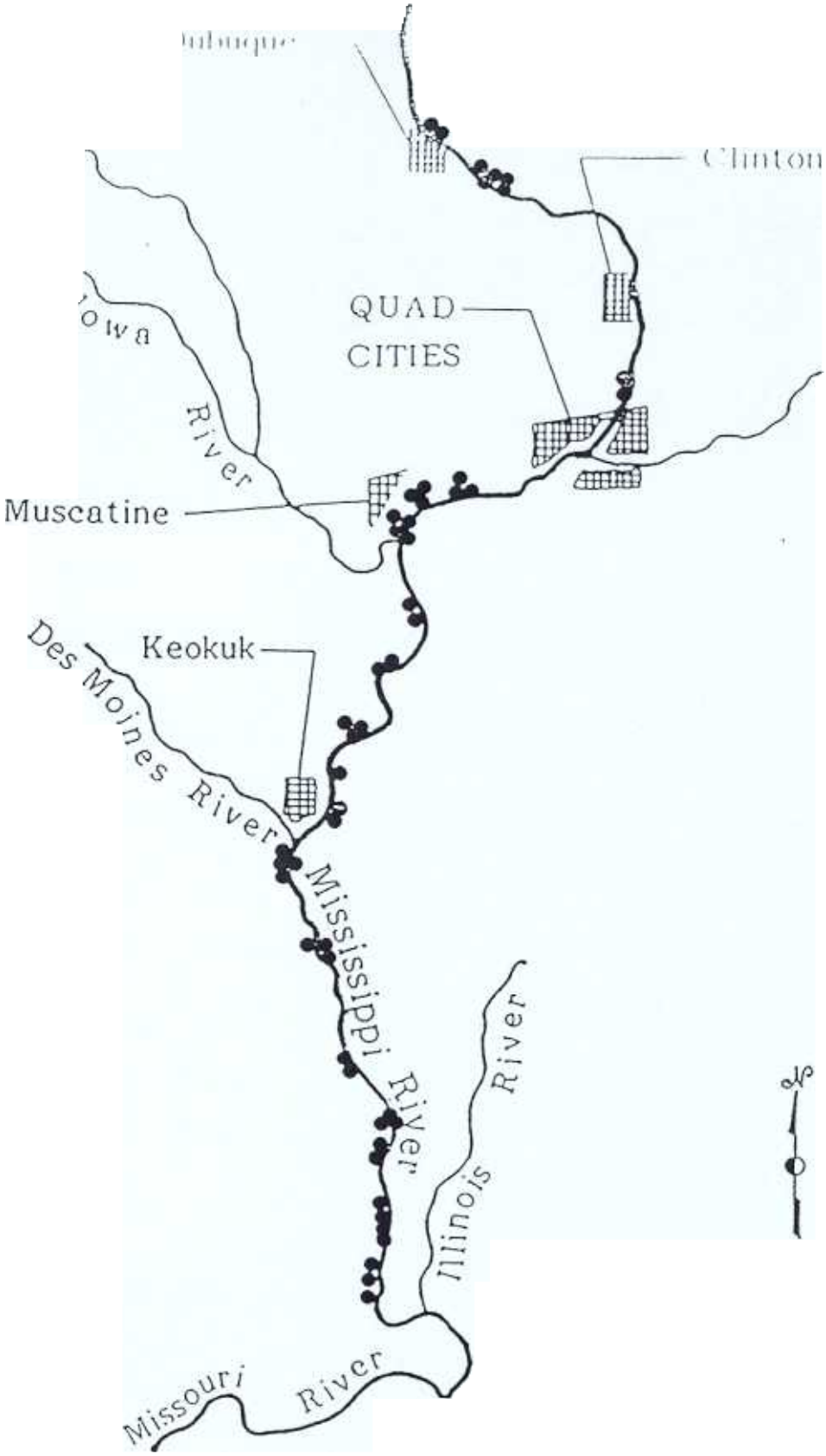

Figure 1. SAMPLING LOCATIONS ON THE UPPER MISSISSIPPI RIVER 1989

Figure 1. SAMPLING LOCATIONS ON THE UPPER MISSISSIPPI RIVER IN 1989 (cont.)

Sampling sites within and adjacent to refuge boundaries were selected based on discussion and recommendations from individual district refuge managers during the field sampling.

Methods

Sample Collections

Bottom sediment samples were collected at 67 sampling locations on the Upper Mississippi River (Figure 1, Table 1). Twenty-one sites were located on national wildlife refuge lands; forty sites were located primarily adjacent to industrial areas, and approximately ten sites were located within important migratory waterfowl usage areas (areas not associated with other federal lands).

One composite bottom sediment sample, comprised of three to five subsamples, was collected at each site. Sediments were collected primarily with a ponar dredge sampler. At a few of the sites where extremely shallow water conditions prevailed, sediment samples were collected by hand with a stainless steel spoon and holding container. The subsamples were placed in acetone-rinsed stainless steel containers and thoroughly mixed, then proportioned into 500 ml acid-cleaned jars with teflon-lined lids. The sampling equipment was rinsed with acetone between each sample site location. The sample containers were labeled and stored at ambient temperature in the field, then later shipped frozen to the analytical facility.

Chemical Analysis

Chemical residue analysis for the organic compounds was performed by Geochemical and Environmental Research Group at Texas A&M University, College Station, Texas. Sediment samples were analyzed for organochlorine compounds, specifically total chlordane, and total and Arochlor specific PCB's, and polycyclic aromatic hydrocarbons. The sediment samples were extracted using the soxhlet extraction method. Freeze-dried samples were homogenized, and a small portion of the sample was weighed into the extraction apparatus and extracted for 12 hours. The organochlorine fraction was isolated by purification of the extracts by silica/aluminum chromatography. The extracts were then analyzed by gas chromatography. The limit of quantification was 0.50 ppm.

Chemical residue analysis for the inorganic compounds was performed by Environmental Trace Substances Research Center, Columbia, Missouri. Sediment samples were analyzed for approximately 18 metals, using Inductively Coupled Plasma (ICP) analysis. Arsenic, mercury, and selenium concentration determinations were made using atomic absorption spectrocepy.

Table 1. UPPER MISSISSIPPI RIVER 1989 SURVEY SAMPLING SITES - BOTTOM SEDIMENTS (Cross-sectional transect sampling locations are marked***).

Sample Location	River Mile(s)	Sample Number	#Samples Collected
Dubuque, IA			
Detention basin	in pond	1	2
Detention basin	in pond	2	
Old Lead Mining Area			
Creek	in creek	3	5
Creek	in creek	4	
Wise Lake (N end)	562.5 L	5	
Wise Lake (Mid sect.)	561.0 L		6
Wise Lake (S end)	560.0 L	7	
Bettendorf, IA			
ALCOA	489 R	8	2
ALCOA/downstream	488 R	9	
Muscatine, IA			
Monsanto Corp.	449.9 R	10	3
Monsanto/upstream	450.3 R	11	
Monsanto/downstream	449.3 R	12	
Big Timber Division Mark Twain NWR	446.5-443		
Big Denny Pond	on refuge	13	3
Little Denny Pond	on refuge	14	
Round Pond	on refuge	15	
Louisa Division Mark Twain NWR	441.5-438 R		
Fox Pond	on refuge	16	4
Goose Pond	on refuge	17	
Prairie Pocket	on refuge	18	
Swarms Pond	on refuge	19	

Table 1 cont. UPPER MISSISSIPPI RIVER 1989 SURVEY SAMPLING SITES - BOTTOM SEDIMENTS (Cross-sectional transect sampling locations are marked***).

Sample Location	River Mile(s)	Sample Number	#Samples Collected
Keithsburg Division Mark Twain NWR	431-428 L		
Upstream side slough	on refuge	20	2
Downstream side slough	on refuge	21	
Burlington, IA			
General Location	403 R	22	2
General Location	401 R	23	
Ft. Madison, IA			
Lead Is. (N end)	387 R	24	3
General Location	381 R	25	
Devils Creek	378 R	26	
George Arthur Refuge (IDOC)			
General location	374.5	27	1
Keokuk, IA			
General Location	365 R	28	2
General Location	363 R	29	
Alexandria, MO	357.0-353.0 R		
Gregory Landing (Grey Chute)	357.0 R	30	4
Gregory Landing (Fox River)		31	
Gregory Landing (Willow Lake)		32	
Gregory Landing (Nelson Lake)		33	

Table 1 cont. UPPER MISSISSIPPI RIVER 1989 SURVEY SAMPLING SITES - BOTTOM SEDIMENTS (Cross-sectional transect sampling locations are marked***).

Sample Location	River Mile(s)	Sample Number	#Samples Collected
Gardner Division Mark Twain NWR	340-332.5 L		
Side slough/ upstream	on refuge	34	3
Side slough/ mid sect.	on refuge	35	
Side slough/ downstream	on refuge	36	
Hannibal, MO			
American Cyanamid Co. /downstream	319.7 R	37	2
Bay de Charles (where ditch enters bay)	in bay	38	
Delair Division Mark Twain NWR	281.5-277.5 L		
N. backwater area	on refuge	39	4
Overflow pond	280.5 L	40	
Swan Lake	on refuge	41	
Hercules Inc.	281 R	42	
Hercules Inc. /downstream	280.5 R	43	
Clarence Cannon NWR	263.5-261.0 R		
Western section		44	4
Southern section		45	
Eastern section		46	
Side slough		47	

Table 1 cont. UPPER MISSISSIPPI RIVER 1989 SURVEY SAMPLING SITES - BOTTOM SEDIMENTS (Cross sectional transect sampling locations are marked***).

Sample Location	River Mile(s)	Sample Number	#Samples Collected
Batchtown Division Mark Twain NWR	251.5-246.0		
Upper Pool		48	3
Middle Pool		49	
Lower Pool		50	
Piasa Harbor/... Dresser Island		51	1
Alton, IL			
Jefferson Smurfit, Inc.	201.4 L	52	1
Wood River, IL			
Wood River STP	197.9 L	53	2
Shell Oil Co.	197.3 L	54	
Hartford, IL			
Clark Oil Co.	196.9 L	55	1
Granite City, IL			
Granite City STP/ Chain-of-Rocks Canal		56	1
East St. Louis, IL			
American Bottoms STP	178.0 L	57	1
St. Louis/... East St. Louis South	168.7	58	1
Meramec River...	160.0	59	1
Herculaneum, MO			
Doe Run Herculaneum	152.0 R	60	

Table 1 cont. UPPER MISSISSIPPI RIVER 1989 SURVEY SAMPLING SITES - BOTTOM SEDIMENTS (cross sectional transect sampling locations are marked***).

Sample Location	River Mile(s)	Sample Number	#Samples Collected
Osbourne Side... Channel	146.5 L	61	1
Crystal City, MO			
La Rouche Chemical Co.	145.O R	62	1
Establishment... Island (vicinity)	132.0	63	1
St. Genevieve... Island (vicinity)	122.0	64	1
Liberty Island... (vicinity)	103.0	65	1
Big Muddy/... Grand Tower Island (vicinity)	72.0 L	66	1
Cape Girardeau, MO... (vicinity)	49.5 R	67	1
Thebes, IL			
Ilada Energy	46.5 L	68	1
Brown's Bar...	25.0	69	1
Angelo Towhead...	3.0 L	70	1

determinations were made using atomic absorption spectrocepy.

Toxicity Tests

Bioassays were performed on sediment samples by the University of Iowa - Hygienics Laboratory in Des Moines, Iowa. Larval fathead minnow 96-hour bioassays were conducted on sub-samples from each site. The standard U.S. Environmental Protection Agency (U.S.EPA) larval fathead minnow technique was employed. One part sediment was mixed with three parts water and allowed to settle for 24 to 48 hours. The pH and oxygen in the test solution were adjusted prior to introduction of test organisms. The organisms (20 to 25 in number) were exposed to the test containers. Dead organisms were removed from the test containers at 24-hour intervals, and their numbers were recorded. A water sample was taken prior to introduction of the test organisms and analyzed for the following parameters: total ammonia, nitrate nitrogen, nitrite nitrogen, organic nitrogen, pH and temperature. The percentage un-ionized ammonia concentrations were calculated from these data.

Results and Discussion

Sediment - Inorganics

The composited sediment samples were analyzed individually for 21 inorganic parameters. The results of the chemical analyses for the inorganics are presented in Appendix A. The concentrations of many of the inorganics did not vary significantly. However, concentrations of some inorganics showed a very wide range at several sampling locations on the Upper Mississippi River. These included aluminum, which ranged from 2730.0 mg/kg at Dubuque, Iowa, to 33300.0 mg/kg at Gregory Landing, near Alexandria, Missouri; barium, which ranged from 4.0 mg/kg at Galena, Illinois (old lead mining area), to 329.0 mg/kg at Clarence Cannon NWR; cadmium, which ranged from <0.02 mg/kg at several locations, including the Mark Twain NWR, to 33.0 mg/kg at Herculaneum, Missouri; chromium, which ranged from 8.9 mg/kg on the Mark Twain NWR (Gardner Division), to 68.0 mg/kg at Granite City, Illinois; copper, which ranged from 5.1 mg/kg on the Mark Twain NWR (Gardner Division), to 1060.0 mg/kg at Herculaneum, Missouri; iron, which ranged from 8000.0 mg/kg at Fort Madison, Iowa, to 89700.0 mg/kg at Herculaneum, Missouri; lead, which ranged from 6.0 mg/kg at Fort Madison, Iowa, to 7720.0 mg/kg at Herculaneum, Missouri; nickel, which ranged from 8.3 mg/kg at Fort Madison, Iowa, to 98.0 mg/kg at Herculaneum, Missouri; silver, which ranged from <2.0 mg/kg at several locations in the study area, to 14.0 mg/kg at Herculaneum, Missouri; strontium, which ranged from 18.2 on the Mark Twain NWR (Louisa Division), mg/kg to 70.6 mg/kg at Herculaneum, Missouri; and zinc, which ranged from 40.7 mg/kg at Fort Madison, Iowa, to 29400.0 mg/kg at Herculaneum, Missouri.

Background concentrations of each of these elements in this portion of the Upper Mississippi River may be represented by the minimum concentrations detected for each element, since many of these minimum concentrations were detected at non-industrial, refuge locations. This indicates that several sites have inorganic contaminants significantly elevated above background, and therefore represent areas of potential concern.

Sediments - Organics

Each composited sediment sample was also analyzed for twenty-five organochlorine compounds. The results of the chemical analyses for the organochlorine compounds are presented in Appendix B. Many of the sampling locations did not exhibit organochlorine contaminants in sediments, as indicated by the "ND" (non-detect) symbols in the data columns. Only two sites at the study area gave any indication of the presence of organochlorine pesticide contaminants in sediments at all. The first site was at Crystal City, Missouri, which indicated polychlorinated biphenyl (PCB) contaminants in bed sediments, where Arochlor 1254 was detected at 1.12 mg/kg, and Arochlor 1260 was detected at 0.22 mg/kg. Another site at the lower end of the study area, Angelo Towhead, which is near Cairo, Illinois, indicated DDE and DDD contaminants present in bed sediments. At Angelo Towhead, o,p'DDE was detected at 0.13 mg/kg; p,p'DDE was detected at 0.35 mg/kg; o,p'DDD was detected at 0.29 mg/kg; and p,p'DDD was detected at 0.65 mg/kg.

Because organochlorine pesticides are man-made compounds, a typically clean environment would contain no detectable concentrations of organochlorines. However, for the few sites that did show some contamination by organochlorines in the present study, the concentrations detected were not indicative of a significant bed sediment contamination problem.

Each composited sediment sample was also analyzed for fourteen polynuclear aromatic hydrocarbon (PAH's) compounds, and oil and grease. The results of the chemical analysis for the polynuclear aromatic hydrocarbons, and oil and grease, are presented in Appendix C. The concentrations of most of the PAH's at many of the sampling sites did not vary significantly. However, concentrations at selected locations did show a wider range than might be anticipated. These particular compounds were phenanthrene, which ranged from non-detectable at several sites, to 2.6 mg/kg at Granite City, Illinois; fluoranthrene, which ranged from non-detectable at several sites, to 2.6 mg/kg at Granite City, Illinois; pyrene, which ranged from non-detectable at several sites, to 1.83 mg/kg at Dubuque, Iowa; and chrysene, which ranged from non-detectable at several sites, to 1.20 mg/kg at Granite City, Illinois. Oil and grease concentrations ranged from non-detectable at a few sites, to 5378 at Dubuque, Iowa.

Because PAH's are considered to be naturally occurring compounds, as well as due to anthropogenic sources, there might be some expectation of background concentrations present in the sediment samples collected from the Upper Mississippi River study area. However, several locations, particularly non-industrialized locations (with a few exceptions) did not exhibit any detectable concentrations of PAH's. Therefore background concentrations of PAH's in the Upper Mississippi River study area are anticipated to be below detection. PAH's appear to be a significant problem at point sources on the Upper Mississippi River.

Bioassay

Sediment exposure bioassays were conducted with composited sediment samples with larval fathead minnows, using a solid-phase sediment and water beaker test technique. The results of the 96-hour fathead minnow bioassays are presented in Appendix D. Water quality parameters were measured for the bioassays conducted for each sediment sample. The water quality parameters measured are presented in Appendix E.

Limitations

There are some additional considerations with regards to sample collection and handling procedures that should at least be acknowledged. First of all, although composited samples were collected at each sampling location, the area in which the subsamples were collected generally did not exceed 30 feet in diameter. Therefore, any significantly widespread areas of bed sediment contamination cannot be predicted from these data. Secondly, with regards to sample handling, recent studies indicate that freezing sediment samples may alter the form of some chemical compounds, particularly polynuclear aromatic hydrocarbons, and some organochlorine compounds. This alteration due to freezing (and subsequent thawing) may have the effect of depressing contaminant concentrations actually measured in a sediment sample. Thus the concentrations listed above in the preceeding tables may actually underestimate concentrations of certain contaminants at many of the sampling sites. Another potential concern is the sample holding time for the samples collected in the present study prior to extraction for analysis. Most samples were held frozen for approximately 6 months, prior to extraction and analysis. Such a lengthy time is generally acceptable for inorganics, but unacceptable for organics.

Summary

Baseline data on inorganic and organic contaminants was developed during the present study. The sediment and water exposure bioassays characterized certain sampling locations as being acutely toxic to aquatic organisms (Table 2). At the specific sampling locations where sediment contaminants were elevated above background, or sediments were significantly toxic to fathead minnows, there is a potential for acute (and chronic) toxicity of sediments to other aquatic organisms, as well as bioaccumulation to other aquatic species, for contaminants known to have the potential to bioaccumulate (Table 3).

It is recommended that additional studies be considered in several areas in the Upper Mississippi River basin to further define the sediment contamination problems suggested by elevated contaminants and/or significant toxicity to aquatic species.

Table 2. A summary of locations on the Upper Mississippi River where sediment toxicity resulted in 50% or greater larval fathead minnow mortality in a 96-hour bioassay (from Appendix D).

River Mile	Location	Contaminants Present
580.7	Dubuque, IA detention basin	Copper, Lead, Zinc, PAHs
561.0	Wise Lake, IL	Metals
403.0	Burlington, IA	Unknown (Ammonia suspected)
381.0	Ft. Madison, IA	Unknown (Ammonia suspected)
357.0	Gregory Landing, MO	Unknown (Ammonia suspected)
340.0	Gardner Division, Mark Twain NWR	Unknown (Ammonia suspected)
178.0	American Bottoms, East St.Louis, IL	Metals, Unknown
80	East St. Louis South, IL	Unknown

Table 3: Summary of the range of metal concentrations sampled, and elevated concentrations, with locations (from Appendix A).

Inorganic Chemical Analyte	Lowest Level Sampled (mg/kg)	Location	Highest Level Sampled (mg/kg)	Location	Elevated Levels (mg/kg)	Location
Aluminum	2730.0	Dubuque	33300.0	Gregory Ld		
Barium	4.0	Galena	329.0	Clar. Cn		
Cadmium	<0.02	Mk Twn NWR	33.0	Herculan.	32.0	Osbourne S.C.
Chromium	8.9	Gardner Div, NWR	68.0	Granite City		
Copper	5.1	Gardner Div, NWR	1060.0	Herculan., MO	1030.0	Osbourn S.C.
Iron	8000.0	Ft. Madison	89700.0	Herculan.		
Lead	6.0	Ft.Madison	7720.0	Herculan.	7590.0 290.9	Osbourn S.C. Am. Bttms
Nickel	8.3	Ft.Madison	98.0	Herculan.	92.0	Osbourn S.C.
Silver	<2.0	several	14.0	Herculan.		
Strontium	18.2	Louisa Div	70.6	Herculan.		
Zinc	40.7	Ft.Madison	29400.0	Herculan.	28800.0 804.0	Osbourn S.C. Galena

Appendix A

Tables A-1 through A-5

Table A-1. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989, Dubuque, IA to Louisa Division Mark Twain NWR.

Sample Location	River Mile(s)	Sample Number	Sample Weight	Percent Moisture	Al	As	Ba	Be	B	Cd	Cr
Dubuque, IA											
Detention basin	in pond	1/1a	875.0	20.9	2730.0	2.9	53.4	0.1	<2.0	0.5	12.0
Detention basin	in pond	2/1b	769.8	30.6	4530.0	2.6	81.2	0.1	3.0	1.2	14.0
Old Lead Mining Area											
Creek	in creek	3/2a									
Creek	in creek	4/2b									
Wise Lake (N end)	562.5 L	5/2d	795.2	53.3	12800.0	5.8	4.0	0.47	4.0	1.6	17.0
Wise Lake (Mid sect.)	561.0 L	6/2e	843.8	39.3	6970.0	2.8	84.3	0.2	<2.0	0.4	11.0
Wise Lake (S end)	560.0 L	7/2f	669.3	55.8	11100.0	5.6	156.0	0.67	<2.0	0.97	21.0
Big Timber Division Mark Twain NWR	446.5-443										
Big Denny Pond	on refuge	13/5a	732.8	51.0	16500.0	5.0	182.0	0.60	4.0	0.4	24.0
Little Denny Pond	on refuge	14/5b	684.6	45.1	32700.0	3.4	257.0	1.2	11.0	0.4	26
Round Pond	on refuge	15/5c	842.1	54.8	16000.0	3.8	167.0	0.67	4.0	0.4	23.0
Louisa Division Mark Twain NWR	441.5-438 R										
Fox Pond	on refuge	16/6a	565.0	57.6	16900.0	3.2	170.0	0.66	4.0	0.4	25.0
Goose Pond	on refuge	17/6b	388.3	43.7	22000.0	3.6	222.0	0.83	5.0	<0.3	27.0
Prairie Pocket	on refuge	18/6c	714.4	58.1	7990.0	5.6	129.0	0.39	3.0	<0.3	12.0
Swarms Pond	on refuge	19/6d	641.8	55.8	16300.0	3.3	161.0	0.88	<2.0	0.4	24.0

Table A-1 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Cu	Fe	Pb	Mg	Mn	Hg	Mo
Dubuque, IA									
Detention basin	in pond	1/1a	16.0	9240.0	140.0	51800.0	310.0	0.084	<2.0
Detention basin	in pond	2/1b	54.8	10100.0	140.0	16200.0	208.0	0.11	<2.0
Old Lead Mining Area									
Creek	in creek	3/2a							
Creek	in creek	4/2b							
Wise Lake (N end)	562.5 L	5/2d	16.0	19200.0	110.0	5950.0	587.0	0.062	<3.0
Wise Lake (Mid sect.)	561.0 L	6/2e	7.8	9880.0	38.0	10300.0	471.0	0.04	<2.0
Wise Lake (S end)	560.0 L	7/2f	18.0	17500.0	88.0	8350.0	729.0	0.070	<2.0
Big Timber Division Mark Twain NWR	446.5-443								
Big Denny Pond	on refuge	13/5a	17.0	21700.0	21.0	5220.0	1010.0	0.062	<3.0
Little Denny Pond	on refuge	14/5b	22.0	29800.0	25.0	6820.0	787.0	0.094	<3.0
Round Pond	on refuge	15/5c	20.0	22600.0	21.0	4720.0	660.0	0.085	<3.0
Louisa Division Mark Twain NWR	441.5-438 R								
Fox Pond	on refuge	16/6a	16.0	22900.0	10.0	2960.0	971.0	0.05	<3.0
Goose Pond	on refuge	17/6b	21.0	27600.0	21.0	4790.0	1190.0	0.062	<3.0
Prairie Pocket	on refuge	18/6c	9.4	19500.0	15.0	2710.0	1600.0	0.05	<3.0
Swarms Pond	on refuge	19/6d	18.0	23200.0	19.0	3550.0	1300.0	0.066	<5.0

Table A-1 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Ni	Se	Ag	Sr	Tl	V	Zn
Dubuque, IA									
Detention basin	in pond	1/1a	9.6	0.2	<2.0	34.5	<4.0	8.0	183.0
Detention basin	in pond	2/1b	14.0	1.3	<2.0	19.3	<4.0	11.0	229.0
Old Lead Mining Area									
Creek	in creek	3/2a							
Creek	in creek	4/2b							
Wise Lake (N end)	562.5 L	5/2d	19.0	0.47	<2.0	28.0	<4.0	24.0	804.0
Wise Lake (Mid sect.)	561.0 L	6/2e	10.0	0.2	<2.0	25.8	<4.0	16.0	215.0
Wise Lake (S end)	560.0 L	7/2f	19.0	0.62	<2.0	31.9	<4.0	19.0	521.0
Big Timber Division Mark Twain NWR	446.5-443								
Big Denny Pond	on refuge	13/5a	20.0	0.43	<2.0	28.0	<4.0	29.0	83.2
Little Denny Pond	on refuge	14/5b	27.0	0.60	<2.0	40.6	<5.0	49.1	106.0
Round Pond	on refuge	15/5c	22.0	0.53	<2.0	24.3	<4.0	28.0	93.0
Louisa Division Mark Twain NWR	441.5-438 R								
Fox Pond	on refuge	16/6a	17.0	0.36	<2.0	23.3	<4.0	31.0	69.8
Goose Pond	on refuge	17/6b	23.0	0.51	<2.0	36.0	<4.0	35.0	86.3
Prairie Pocket	on refuge	18/6c	16.0	0.42	<2.0	18.2	<4.0	21.0	44.4
Swarms Pond	on refuge	19/6d	19.0	0.3	<2.0	24.0	<4.0	23.0	65.5

Table A-2. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989, Keithsburg Division Mark Twain NWR to Alexandria, MO.

Sample Location	River Mile(s)	Sample Number	Sample Weight	Percent Moisture	Al	As	Ba	Be	B	Cd	Cr
Keithsburg Division Mark Twain NWR	431-428 L										
Upstream side slough	on refuge	20/7a	657.4	54.5	12000.0	3.2	102.0	0.56	5.0	0.4	28.0
Downstream side slough	on refuge	21/7b	571.3	69.5	24700.0	5.8	252.0	0.91	6.0	0.5	29.0
Burlington, IA											
General Location	403 R	22/8a	694.0	55.3	13900.0	4.6	180.0	0.59	4.0	0.4	19.0
General Location	401 R	23/8b	669.2	56.3	14000.0	3.3	180.0	0.76	<2.0	0.4	27.0
Ft. Madison, IA											
Lead Is. (N end)	387 R	24/9a	765.4	30.6	10800.0	2.8	120.0	0.50	3.0	<0.3	14.0
General Location	381 R	25/9b									
Devils Creek	378 R	26/9c	700.3	33.1	6990.0	2.0	94.9	0.34	3.0	<0.3	9.5
Alexandria, MO	357.0-353.0 R										
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	752.1	51.2	17600.0	7.3	254.0	0.78	4.0	<0.2	22.0
Gregory Landing (Fox River)		31/MR-48	717.3	41.1	16300.0	4.3	175.0	0.60	3.0	<0.2	18.0
Gregory Landing (Willow Lake)		32/MR-49	403.0	33.2	29900.0	4.9	300.0	1.2	5.0	<0.2	31.0
Gregory Landing (Nelson Lake)		33/MR-50	796.4	52.6	33300.0	4.5	317.0	1.3	6.0	<0.2	35.0

Table A-2 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Cu	Fe	Pb	Mg	Mn	Hg	Mo
Keithsburg Division Mark Twain NWR	431-428 L								
Upstream side slough	on refuge	20/7a	14.0	17500.0	10.0	2910.0	569.0	0.04	<2.0
Downstream side slough	on refuge	21/7b	23.0	35300.0	24.0	5290.0	2730.0	0.074	<4.0
Burlington, IA									
General Location	403 R	22/8a	17.0	18300.0	29.0	4380.0	1060.0	0.058	<2.0
General Location	401 R	23/8b	17.0	19300.0	19.0	4940.0	1230.0	0.079	<3.0
Ft. Madison, IA									
Lead Is. (N end)	387 R	24/9a	9.0	13300.0	9.0	2540.0	527.0	0.04	<2.0
General Location	381 R	25/9b							
Devils Creek	378 R	26/9c	7.0	8000.0	6.0	1890.0	317.0	0.03	<2.0
Alexandria, MO	357.0-353.0 R								
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	17.0	25900.0	10.0	3890.0	995.0	0.04	<3.0
Gregory Landing (Fox River)		31/MR-48	13.0	18100.0	8.0	2380.0	653.0	0.03	<2.0
Gregory Landing (Willow Lake)		32/MR-49	25.0	31300.0	16.0	4020.0	496.0	0.069	<4.0
Gregory Landing (Nelson Lake)		33/MR-50	25.7	33700.0	16.0	4590.0	641.0	0.062	<4.0

Table A-2 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Ni	Se	Ag	Sr	Tl	V	Zn
Keithsburg Division Mark Twain NWR	431-428 L								
Upstream side slough	on refuge	20/7a	19.0	1.0	<2.0	21.1	<4.0	29.0	91.5
Downstream side slough	on refuge	21/7b	26.0	0.78	3.0	37.2	<4.0	36.0	05.0
Burlington, IA									
General Location	403 R	22/8a	17.0	0.57	<2.0	32.3	<4.0	24.0	76.7
General Location	401 R	23/8b	19.0	0.40	<2.0	31.1	<4.0	20.0	99.7
Ft. Madison, IA									
Lead Is. (N end)	387 R	24/9a	14.0	0.2	<2.0	18.3	<4.0	22.0	40.7
General Location	381 R	25/9b							
Devils Creek	378 R	26/9c	8.3	0.2	<2.0	21.6	<4.0	14.0	27.0
Alexandria, MO	357.0-353.0 R								
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	23.3	0.76	3.0	44.9	<4.0	32.0	67.4
Gregory Landing (Fox River)		31/MR-48	17.0	0.44	<2.0	26.0	<4.0	27.0	42.9
Gregory Landing (Willow Lake)		32/MR-49	31.0	0.54	3.0	37.4	<4.0	43.0	86.2
Gregory Landing (Nelson Lake)		33/MR-50	30.0	0.55	3.0	1.4	<4.0	45.9	88.9

Table A-3. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989, Gardner Division Mark Twain NWR to Batchtown Division Mark Twain NWR.

Sample Location	River Mile(s)	Sample Number	Sample Weight	Percent Moisture	Al	As	Ba	Be	B	Cd	Cr
Gardner Division Mark Twain NWR	340-332.5 L										
Side slough/ upstream	on refuge	34/12a	709.6	44.0	9980.0	2.5	125.0	0.50	3.0	<0.3	14.0
Side slough/ mid sect.	on refuge	35/12b	808.7	31.7	5850.0	.6	66.6	0.1	<2.0	<0.3	8.9
Side slough/ downstream	on refuge	36/12c	786.7	34.7	8190.0	2.0	88.1	0.2	2.0	0.3	11.0
Delair Division Mark Twain NWR	281.5-277.5 L										
N. backwater area	on refuge	39/MR-16	820.8	50.8	13000.0	2.8	152.0	0.54	3.0	<0.2	18.0
Overflow pond	280.5 L	40/MR-17	910.3	48.2	28000.0	1.6	203.0	0.85	7.8	<0.2	19.0
Swan Lake	on refuge	41/MR-18	797.7	40.6	9430.0	1.5	136.0	0.45	<2.0	<0.2	14.0
Hercules Inc.	281 R	42/MR-14	856.7	49.9	22000.0	5.6	174.0	0.66	6.0	0.4	26.0
Hercules Inc. /downstream	280.5 R	43/MR-15	877.9	40.5	13000.0	2.7	131.0	0.39	2.0	<0.3	17.0
Clarence Cannon NWR	263.5-261.0 R										
Western section		44/MR-19	821.3	46.3	28200.0	1.8	242.0	1.3	4.0	<0.2	30.0
Southern section		45/MR-20	668.8	60.2	46900.0	3.3	329.0	1.4	7.5	0.2	43.0
Eastern section		46/MR-21	830.9	46.5	31500.0	2.4	259.0	1.2	4.0	0.3	36.0
Side slough		47/MR-22	772.1	51.9	19100.0	2.2	194.0	0.85	4.0	<0.2	22.0
Batchtown Division Mark Twain NWR	251.5-246.0										
Upper Pool		48/MR-23	700.7	54.7	25200.0	5.5	251.0	1.0	5.0	<0.2	29.0
Middle Pool		49/MR-24	815.1	54.5	22800.0	4.7	255.0	1.1	5.0	<0.4	28.0
Lower Pool		50/MR-25	787.5	53.3	22300.0	3.5	226.0	0.95	3.0	<0.2	27.0

Table A-3 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Cu	Fe	Pb	Mg	Mn	Hg	Mo
Gardner Division Mark Twain NWR	340-332.5 L								
Side slough/ upstream	on refuge	34/12a	9.2	13200.0	10.0	2910.0	729.0	0.04	<2.0
Side slough/ mid sect.	on refuge	35/12b	5.1	8440.0	7.0	1840.0	389.0	<0.02	<2.0
Side slough/ downstream	on refuge	36/12c	6.6	10300.0	7.0	2300.0	426.0	<0.02	<2.0
Delair Division Mark Twain NWR	281.5-277.5 L								
N. backwater area	on refuge	39/MR-16	12.0	16000.0	10.0	3690.0	641.0	0.02	<2.0
Overflow pond	280.5 L	40/MR-17	15.0	25400.0	10.0	3830.0	622.0	0.02	<3.0
Swan Lake	on refuge	41/MR-18	8.8	17600.0	9.0	1650.0	1240.0	0.02	<2.0
Hercules Inc.	281 R	42/MR-14	17.0	20600.0	17.0	3260.0	595.0	0.03	<3.0
Hercules Inc. /downstream	280.5 R	43/MR-15	9.7	14100.0	10.0	2660.0	625.0	0.02	<2.0
Clarence Cannon NWR	263.5-261.0 R								
Western section		44/MR-19	23.0	26200.0	16.0	4230.0	412.0	0.02	<3.0
Southern section		45/MR-20	27.8	34700.0	20.0	5600.0	677.0	0.03	<4.0
Eastern section		46/MR-21	24.0	27300.0	17.0	3680.0	560.0	0.03	<3.0
Side slough		47/MR-22	16.0	21200.0	15.0	2710.0	466.0	0.02	<3.0
Batchtown Division Mark Twain NWR	251.5-246.0								
Upper Pool		48/MR-23	22.0	32200.0	20.0	5050.0	1800.0	0.062	<4.0
Middle Pool		49/MR-24	25.0	31300.0	22.0	5260.0	1360.0	0.05	<4.0
Lower Pool		50/MR-25	20.0	27800.0	18.0	4510.0	1150.0	0.03	<3.0

Table A-3 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Ni	Se	Ag	Sr	Tl	V	Zn
Gardner Division Mark Twain NWR	340-332.5 L								
Side slough/ upstream	on refuge	34/12a	13.0	0.3	<2.0	27.6	<4.0	19.0	49.7
Side slough/ mid sect.	on refuge	35/12b	8.7	0.2	<2.0	20.1	<4.0	13.0	28.5
Side slough/ downstream	on refuge	36/12c	11.0	0.2	<2.0	23.6	<4.0	16.0	35.7
Delair Division Mark Twain NWR	281.5-277.5 L								
N. backwater area	on refuge	39/MR-16	16.0	0.5	<2.0	30.2	<4.0	23.0	57.3
Overflow pond	280.5 L	40/MR-17	19.0	0.2	3.0	37.8	<4.0	41.1	65.7
Swan Lake	on refuge	41/MR-18	11.0	0.2	<2.0	28.5	<4.0	16.0	34.1
Hercules Inc.	281 R	42/MR-14	20.0	0.3	<2.0	33.4	<4.0	37.0	88.9
Hercules Inc. /downstream	280.5 R	43/MR-15	14.0	0.2	<2.0	27.3	<4.0	24.0	46.6
Clarence Cannon NWR	263.5-261.0 R								
Western section		44/MR-19	25.0	0.4	2.0	33.2	<4.0	35.0	86.5
Southern section		45/MR-20	33.0	0.67	3.0	51.5	<4.0	61.8	13.0
Eastern section		46/MR-21	26.0	0.48	2.0	41.7	<4.0	38.7	04.0
Side slough		47/MR-22	22.0	0.53	<2.0	25.2	<4.0	31.0	68.1
Batchtown Division Mark Twain NWR	251.5-246.0								
Upper Pool		48/MR-23	28.0	0.46	3.0	34.9	<4.0	39.0	94.7
Middle Pool		49/MR-24	28.0	0.54	3.0	31.6	<4.0	37.0	99.6
Lower Pool		50/MR-25	25.0	0.46	2.0	30.5	<4.0	35.0	88.5

Table A-4. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989, Piasa Harbor/Dresser Island to Osbourne Side Channel.

Sample Location	River Mile(s)	Sample Number	Sample Weight	Percent Moisture	Al	As	Ba	Be	B	Cd	Cr
Piasa Harbor/ Dresser Island											
	209.0	51/MR-44	925.0	46.5	14000.0	3.1	144.0	0.53	4.0	<0.2	19.0
Alton, IL											
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	921.7	27.0	9120.0	4.5	123.0	0.46	3.0	<0.2	13.0
Wood River, IL											
Wood River STP	197.9 L	53/MR-27	1093.7	30.6	6930.0	2.3	81.2	0.36	2.0	<0.2	12.0
Shell Oil Co.	197.3 L	54/MR-28	1065.0	37.9	5760.0	2.2	81.9	0.31	3.0	<0.2	19.0
Hartford, IL											
Clark Oil Co.	196.9 L	55/MR-29	919.9	30.5	10700.0	6.8	226.0	0.58	3.0	0.4	25.0
Granite City, IL											
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	994.7	31.3	6600.0	5.4	204.0	0.3	3.0	1.3	68.0
East St. Louis, IL											
American Bottoms STP	178.0 L	57/MR-31	906.3	25.1	7260.0	11.5	210.0	0.3	3.0	0.8	12.0
St. Louis/ East St. Louis South	168.7	58/MR-32	906.0	43.9	15500.0	5.4	240.0	0.60	4.0	0.4	19.0
Meramec River	160.0	59/MR-33	896.2	31.7	16100.0	4.9	238.0	0.63	4.0	0.7	20.0
Herculaneum, MO											
Doe Run Herculaneum	152.0 R	60/MR-34	1403.7	19.4	11100.0	15.3	212.0	1.2	9.0	33.0	25.0
Osbourne Side Channel	146.5 L	61/MR-35	549.3	40.4	11000.0	5.2	213.0	1.2	.7	2.0	25.0

Table A-4 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Cu	Fe	Pb	Mg	Mn	Hg	Mo
Piasa Harbor/ Dresser Island	209.0	51/MR44	14.0	17400	10.0	3860.0	650.0	0.04	<2.0
Alton, IL									
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	12.0	15000.0	15.0	2950.0	512.0	0.04	<2.0
Wood River, IL									
Wood River STP	197.9 L	53/MR-27	11.0	10500.0	16.0	3430.0	419.0	0.03	<2.0
Shell Oil Co.	197.3 L	54/MR-28	9.6	9720.0	15.0	2880.0	406.0	0.02	<2.0
Hartford, IL									
Clark Oil Co.	196.9 L	55/MR-29	48.4	20100.0	43.0	4510.0	921.0	0.44	<3.0
Granite City, IL									
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	84.6	41800.0	140.0	2370.0	351.0	0.18	<4.0
East St. Louis, IL									
American Bottoms STP	178.0 L	57/MR-31	40.5	9740.0	290.0	2580.0	233.0	0.04	<2.0
St. Louis/ East St. Louis South	168.7	58/MR-32	21.0	19200.0	24.0	4570.0	782.0	0.05	<3.0
Meramec River	160.0	59/MR-33	18.0	19000.0	37.0	4590.0	796.0	0.04	<3.0
Herculaneum, MO									
Doe Run Herculaneum	152.0 R	60/MR-34	1060.0	89700.0	7720.0	12600.0	589.0	0.03	20.0
Osbourne Side Channel	146.5 L	61/MR-35	1030.0	88200.0	7590.0	2500.0	588.0	0.056	20.0

Table A-4 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Ni	Se	Ag	Sr	Tl	V	Zn
Piasa Harbor/ Dresser Island									
Alton, IL	209.0	51/MR-44	18.0	0.44	<2.0	29.3	<4.0	24.0	62.8
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	16.0	0.3	<2.0	21.2	<4.0	20.0	52.9
Wood River, IL									
Wood River STP	197.9 L	53/MR-27	12.0	0.2	<2.0	22.3	<4.0	15.0	45.1
Shell Oil Co.	197.3 L	54/MR-28	11.0	0.2	<2.0	31.4	<4.0	13.0	38.2
Hartford, IL									
Clark Oil Co.	196.9 L	55/MR-29	20.0	0.3	<2.0	49.3	<4.0	25.0	99.7
Granite City, IL									
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	39.0	0.57	4.0	38.4	<4.0	14.0	187.0
East St. Louis, IL									
American Bottoms STP	178.0 L	57/MR-31	13.0	0.3	3.0	32.3	<4.0	16.0	130.0
St. Louis/ East St. Louis South	168.7	58/MR-32	23.0	0.44	<2.0	48.7	<4.0	29.0	98.0
Meramec River	160.0	59/MR-33	22.0	0.42	<2.0	40.1	<4.0	29.0	101.0
Herculaneum, MO									
Doe Run Herculaneum	52.0 R	60/MR-34	98.0	0.59	14.0	70.6	<4.0	29.0	29400.0
Osbourne Side Channel	46.5 L	1/MR-35	92.0	.54	14.0	69.9	<4.0	29.0	28800.0

Table A-5. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989, Crystal City, MO to Angelo Towhead.

Sample Location	River Mile(s)	Sample Number	Sample Weight	Percent Moisture	Al	As	Ba	Be	B	Cd	Cr
Crystal City, MO											
La Rouche Chemical Co.	145.0 R	62/MR-36	1037.8	24.7	9010.0	4.3	176.0	0.33	3.0	<0.2	27.0
Establishment Island (vicinity)	132.0	63/MR-37	1009.5	40.5	14300.0	4.8	224.0	0.55	4.0	0.5	18.0
St. Genevieve Island (vicinity)	122.0	64/MR-38	769.3	33.7	19000.0	5.9	242.0	0.64	5.0	0.3	22.0
Liberty Island (vicinity)	103.0	65/MR-39	886.7	46.2	23200.0	6.7	247.0	0.86	5.0	0.3	26.0
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	841.0	41.9	17300.0	5.1	218.0	0.72	5.0	<0.2	19.0
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	961.9	36.2	11200.0	4.2	197.0	0.44	3.0	<0.2	14.0
Thebes, IL											
Ilada Energy	46.5 L	68/MR-41	919.8	31.8	14900.0	6.1	267.0	0.52	5.0	<0.2	20.0
Brown's Bar	5.0	69/MR-42	798.6	53.0	27700.0	7.2	289.0	0.99	5.0	0.4	30.0
Angelo Towhead	3.0 L	70/MR-45	821.2	47.2	18000.0	5.3	242.0	0.77	5.0	0.3	21.0

Table A-5 continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Cu	Fe	Pb	Mg	Mn	Hg	Mo
Crystal City, MO									
La Rouche Chemical Co.	145.0 R	62/MR-36	13.0	11500.0	23.0	2510.0	490.0	0.04	<2.0
Establishment Island (vicinity)	132.0	63/MR-37	16.0	17000.0	23.0	4220.0	647.0	0.05	<2.0
St. Genevieve Island (vicinity)	122.0	64/MR-38	17.0	19900.0	20.0	4430.0	743.0	0.073	<3.0
Liberty Island (vicinity)	103.0	65/MR-39	23.0	25200.0	24.0	5260.0	979.0	0.070	<3.0
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	17.0	20400.0	16.0	4390.0	937.0	0.05	<3.0
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	12.0	14400.0	16.0	3740.0	651.0	0.04	<2.0
Thebes, IL									
Ilada Energy	46.5 L	68/MR-41	14.0	17000.0	14.0	4520.0	585.0	0.057	<2.0
Brown's Bar	5.0	69/MR-42	24.0	28100.0	23.0	6110.0	1200.0	0.063	<3.0
Angelo Towhead	3.0 L	70/MR-45	19.0	22300.0	20.0	4760.0	1010.0	0.055	<3.0

Table A-5, continued. Concentrations (mg/kg dry weight) of inorganic elements detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Ni	Se	Ag	Sr	Tl	V	Zn
Crystal City, MO									
La Rouche Chemical Co.	145.0 R	62/MR-36	13.0	0.2	<2.0	28.6	<4.0	19.0	83.6
Establishment Island (vicinity)	132.0	63/MR-37	19.0	0.41	<2.0	43.5	<4.0	27.0	86.1
St. Genevieve Island (vicinity)	122.0	64/MR-38	21.0	0.52	<2.0	52.0	<4.0	32.0	70.8
Liberty Island (vicinity)	103.0	65/MR-39	27.0	0.67	<2.0	54.3	<4.0	37.6	94.9
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	23.0	0.49	<2.0	46.3	<4.0	31.0	71.8
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	17.0	0.4	<2.0	40.3	<4.0	21.0	54.3
Thebes, IL									
Ilada Energy	46.5 L	68/MR-41	20.0	0.42	<2.0	44.1	<4.0	29.0	62.9
Brown's Bar	5.0	69/MR-42	31.0	0.68	3.0	67.6	<4.0	44.0	95.2
Angelo Towhead	3.0 L	70/MR-45	25.0	0.45	2.0	47.0	<4.0	33.0	79.9

Appendix B

Tables B-1 through B-5

Table B-1. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989, Dubuque, IA to Louisa Division Mark Twain NWR.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	HCB	Alpha BHC	Beta BHC	Gamma BHC	Delta BHC	Heptachlor Epoxide
Dubuque, IA										
Detention basin	in pond	1/1a	911	18.0	ND	ND	ND	ND	ND	ND
Detention basin	in pond	2/1b	649	29.0	ND	ND	ND	ND	ND	ND
Old Lead Mining Area										
Creek	in creek	3/2a								
Creek	in creek	4/2b								
Wise Lake (N end)	562.5 L	5/2d	824	52.8	ND	ND	ND	ND	ND	ND
Wise Lake (Mid sect.)	561.0 L	6/2e	783	36.2	ND	ND	ND	ND	ND	ND
Wise Lake (S end)	560.0 L	7/2f		60.6	ND	ND	ND	ND	ND	ND
Big Timber Division Mark Twain NWR	446.5-443									
Big Denny Pond	on refuge	13/5a	667	69.4	ND	ND	ND	ND	ND	ND
Little Denny Pond	on refuge	14/5b	740	57.8	ND	ND	ND	ND	ND	ND
Round Pond	on refuge	15/5c	799	60.2	ND	ND	ND	ND	ND	ND
Louisa Division Mark Twain NWR	441.5-438 R									
Fox Pond	on refuge	16/6a	517	56.4	ND	ND	ND	ND	ND	ND
Goose Pond	on refuge	17/6b	726	69.2	ND	ND	ND	ND	ND	ND
Prairie Pocket	on refuge	18/6c	656	54.2	ND	ND	ND	ND	ND	ND
Swarms Pond	on refuge	19/6d	849	63.0	ND		ND	ND	ND	ND

Table B-1 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Oxy-chlordane	Alpha-chlordane	Gamma chlordane	Cis-Nonachlor	Trans-Nonachlor	Dieldrin	Endrin	Mirex
Dubuque, IA										
Detention basin	in pond	1/1a	ND	ND	ND	ND	ND	ND	ND	ND
Detention basin	in pond	2/1b	ND	ND	ND	ND	ND	ND	ND	ND
Old Lead Mining Area										
Creek	in creek	3/2a								
Creek	in creek	4/2b								
Wise Lake (N end)	562.5 L	5/2d	ND	ND	ND	ND	ND	ND	ND	ND
Wise Lake (Mid sect.)	561.0 L	6/2e	ND	ND	ND	ND	ND	ND	ND	ND
Wise Lake (S end)	560.0 L	7/2f	ND	ND	ND	ND	ND	ND	ND	ND
Big Timber Division Mark Twain NWR	446.5-443									
Big Denny Pond	on refuge	13/5a	ND	ND	ND	ND	ND	ND	ND	ND
Little Denny Pond	on refuge	14/5b	ND	ND	ND	ND	ND	ND	ND	ND
Round Pond	on refuge	15/5c	ND	ND	ND	ND	ND	ND	ND	ND
Louisa Division Mark Twain NWR	441.5-438 R									
Fox Pond	on refuge	16/6a	ND	ND	ND	ND	ND	ND	ND	ND
Goose Pond	on refuge	17/6b	ND	ND	ND	ND	ND	ND	ND	ND
Prairie Pocket	on refuge	18/6c	ND	ND	ND	ND	ND	ND	ND	ND
Swarms Pond	on refuge	19/6d	ND	ND	ND	ND	ND	ND	ND	ND

Table B-1 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	o,p'DDE	p,p'DDE	o,p'DDD	p,p'DDD	o,p'DDT	p,p'DDT
Dubuque, IA								
Detention basin	in pond	1/1a	ND	ND	ND	ND	ND	ND
Detention basin	in pond	2/1b	ND	ND	ND	ND	ND	ND
Old Lead Mining Area								
Creek	in creek	3/2a						
Creek	in creek	4/2b						
Wise Lake (N end)	562.5 L	5/2d	ND	ND	ND	ND	ND	ND
Wise Lake (Mid sect.)	561.0 L	6/2e	ND	ND	ND	ND	ND	ND
Wise Lake (S end)	560.0 L	7/2f	ND	ND	ND	ND	ND	ND
Big Timber Division Mark Twain NWR	446.5-443							
Big Denny Pond	on refuge	13/5a	ND	ND	ND	ND	ND	ND
Little Denny Pond	on refuge	14/5b	ND	ND	ND	ND	ND	ND
Round Pond	on refuge	15/5c	ND	ND	ND	ND	ND	ND
Louisa Division Mark Twain NWR	441.5-438 R							
Fox Pond	on refuge	16/6a	ND	ND	ND	ND	ND	ND
Goose Pond	on refuge	17/6b	ND	ND	ND	ND	ND	ND
Prairie Pocket	on refuge	18/6c	ND	ND	ND	ND	ND	ND
Swarms Pond	on refuge	19/6d	ND	ND	ND	ND	ND	ND

Table B-1 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Toxaphene
Dubuque, IA							
Detention basin	in pond	1/1a	ND	ND	ND	ND	ND
Detention basin	in pond	2/1b	ND	ND	ND	ND	ND
Old Lead Mining Area							
Creek	in creek	3/2a					
Creek	in creek	4/2b					
Wise Lake (N end)	562.5 L	5/2d	ND	ND	ND	ND	ND
Wise Lake (Mid sect.)	561.0 L	6/2e	ND	ND	ND	ND	ND
Wise Lake (S end)	560.0 L	7/2f	ND	ND	ND	ND	ND
Big Timber Division Mark Twain NWR	446.5-443						
Big Denny Pond	on refuge	13/5a	ND	ND	ND	ND	ND
Little Denny Pond	on refuge	14/5b	ND	ND	ND	ND	ND
Round Pond	on refuge	15/5c	ND	ND	ND	ND	ND
Louisa Division Mark Twain NWR	441.5-438 R						
Fox Pond	on refuge	16/6a	ND	ND	ND	ND	ND
Goose Pond	on refuge	17/6b	ND	ND	ND	ND	ND
Prairie Pocket	on refuge	18/6c	ND	ND	ND	ND	ND
Swamms Pond	on refuge	19/6d	ND	ND	ND	ND	ND

Table B-2. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989, Keithsburg Division Mark Twain NWR to Alexandria, MO.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	HCB	Alpha BHC	Beta BHC	Gamma BHC	Delta BHC	Heptachlor Epoxide
Keithsburg Division Mark Twain NWR	431-428 L									
Upstream side slough	on refuge	20/7a	694	56.8	ND	ND	ND	ND	ND	ND
Downstream side slough	on refuge	21/7b	556	76.0	ND	ND	ND	ND	ND	ND
Burlington, IA										
General Location	403 R	22/8a	700	60.4	ND	ND	ND	ND	ND	ND
General Location	401 R	23/8b	639	61.8	ND	ND	ND	ND	ND	ND
Ft. Madison, IA										
Lead Is. (N end)	387 R	24/9a	800	31.2	ND	ND	ND	ND	ND	ND
General Location	381 R	25/9b								
Devils Creek	378 R	26/9c	696	31.6	ND	ND	ND	ND	ND	ND
Alexandria, MO	357.0-353.0 R									
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	744	60.6	ND	ND	ND	ND	ND	ND
Gregory Landing (Fox River)		31/MR-48	673	46.4	ND	ND	ND	ND	ND	ND
Gregory Landing (Willow Lake)		32/MR-49	423	31.0	ND	ND	ND	ND	ND	ND
Gregory Landing (Nelson Lake)		33/MR-50	765	57.8	ND	ND	ND	ND	ND	ND

Table B-2 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Oxy-chlordane	Alpha-chlordane	Gamma chlordane	Cis-Nonachlor	Trans-Nonachlor	Dieldrin	Endrin	Mirex
Keithsburg Division Mark Twain NWR	431-428 L									
Upstream side slough	on refuge	20/7a	ND	ND	ND	ND	ND	ND	ND	ND
Downstream side slough	on refuge	21/7b	ND	ND	ND	ND	ND	ND	ND	ND
Burlington, IA										
General Location	403 R	22/8a	ND	ND	ND	ND	ND	ND	ND	ND
General Location	401 R	23/8b	ND	ND	ND	ND	ND	ND	ND	ND
Ft. Madison, IA										
Lead Is. (N end)	387 R	24/9a	ND	ND	ND	ND	ND	ND	ND	ND
General Location	381 R	25/9b								
Devils Creek	378 R	26/9c	ND	ND	ND	ND	ND	ND	ND	ND
Alexandria, MO	357.0-353.0 R									
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	ND	ND	ND	ND	ND	ND	ND	ND
Gregory Landing (Fox River)		31/MR-48	ND	ND	ND	ND	ND	ND	ND	ND
Gregory Landing (Willow Lake)		32/MR-49	ND	ND	ND	ND	ND		ND	ND
Gregory Landing (Nelson Lake)		33/MR-50	ND	ND	ND	ND	ND		ND	ND

Table B-2 continued. Concentrations (ng/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	o,p'DDE	p,p'DDE	o,p'DDD	p,p'DDD	o,p'DDT	p,p'DDT
Keithsburg Division Mark Twain NWR	431-428 L							
Upstream side slough	on refuge	20/7a	ND	ND	ND	ND	ND	ND
Downstream side slough	on refuge	21/7b	ND	ND	ND	ND	ND	ND
Burlington, IA								
General Location	403 R	22/8a	ND	ND	ND	ND	ND	ND
General Location	401 R	23/8b	ND	ND	ND	ND	ND	ND
Ft. Madison, IA								
Lead Is. (N end)	387 R	24/9a	ND	ND	ND	ND	ND	ND
General Location	381 R	25/9b						
Devils Creek	378 R	26/9c	ND	ND	ND	ND	ND	ND
Alexandria, MO	357.0-353.0 R							
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	ND	ND	ND	ND	ND	ND
Gregory Landing (Fox River)		31/MR-48	ND	ND	ND	ND	ND	ND
Gregory Landing (Willow Lake)		32/MR-49	ND	ND	ND	ND	ND	ND
Gregory Landing (Nelson Lake)		33/MR-50	ND	ND	ND	ND	ND	ND

Table B-2 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Toxaphene
Keithsburg Division Mark Twain NWR	431-428 L						
Upstream side slough	on refuge	20/7a	ND	ND	ND	ND	ND
Downstream side slough	on refuge	21/7b	ND	ND	ND	ND	ND
Burlington, IA							
General Location	403 R	22/8a	ND	ND	ND	ND	ND
General Location	401 R	23/8b	ND	ND	ND	ND	ND
Ft. Madison, IA							
Lead Is. (N end)	387 R	24/9a	ND	ND	ND	ND	ND
General Location	381 R	25/9b					
Devils Creek	378 R	26/9c	ND	ND	ND	ND	ND
Alexandria, MO	357.0-353.0 R						
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	ND	ND	ND	ND	ND
Gregory Landing (Fox River)		31/MR-48	ND	ND	ND	ND	ND
Gregory Landing (Willow Lake)		32/MR-49	ND	ND	ND	ND	ND
Gregory Landing (Nelson Lake)		33/MR-50	ND	ND	ND	ND	ND

Table B-3. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989, Gardner Division Mark Twain NWR to Batchtown Division Mark Twain NWR.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	HCB	Alpha BHC	Beta BHC	Gamma BHC	Delta BHC	Heptachlor Epoxide
Gardner Division Mark Twain NWR	340-332.5 L									
Side slough/ upstream	on refuge	34/12a	802	49.8	ND	ND	ND	ND	ND	ND
Side slough/ mid sect.	on refuge	35/12b	760	33.4	ND	ND	ND	ND	ND	ND
Side slough/ downstream	on refuge	36/12c	672	31.6	ND	ND	ND	ND	ND	ND
Delair Division Mark Twain NWR	281.5-277.5 L									
N. backwater area	on refuge	39/MR-16	766	49.8	ND	ND	ND	ND	ND	ND
Overflow pond	280.5 L	40/MR-17	879	43.4	ND	ND	ND	ND	ND	ND
Swan Lake	on refuge	41/MR-18	718	41.4	ND	ND	ND	ND	ND	ND
Hercules Inc.	281 R	42/MR-14	826	49.6	ND	ND	ND	ND	ND	ND
Hercules Inc. /downstream	280.5 R	43/MR-15	915	28.0	ND	ND	ND	ND	ND	ND
Clarence Cannon NWR	263.5-261.0 R									
Western section		44/MR-19	813	44.4	ND	ND	ND	ND	ND	ND
Southern section		45/MR-20	752	63.6	ND	ND	ND	ND	ND	ND
Eastern section		46/MR-21	781	47.4	ND	ND	ND	ND	ND	ND
Side slough		47/MR-22	843	50.8	ND	ND	ND	ND	ND	ND
Batchtown Division Mark Twain NWR	251.5-246.0									
Upper Pool		48/MR-23		57.6			ND	ND	ND	ND
Middle Pool		49/MR-24		59.0			ND	ND	ND	ND
Lower Pool		50/MR-25		59.4			ND	ND	ND	ND

Table B-3 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Oxy-chlordane	Alpha-chlordane	Gamma chlordane	Cis-Nonachlor	Trans-Nonachlor	Dieldrin	Endrin	Mirex
Gardner Division Mark Twain NWR	340-332.5 L									
Side slough/ upstream	on refuge	34/12a	ND	ND	ND	ND	ND	ND	ND	ND
Side slough/ mid sect.	on refuge	35/12b	ND	ND	ND	ND	ND	ND	ND	ND
Side slough/ downstream	on refuge	36/12c	ND	ND	ND	ND	ND	ND	ND	ND
Delair Division Mark Twain NWR	281.5-277.5 L									
N. backwater area	on refuge	39/MR-16	ND	ND	ND	ND	ND	ND	ND	ND
Overflow pond	280.5 L	40/MR-17	ND	ND	ND	ND	ND	ND	ND	ND
Swan Lake	on refuge	41/MR-18	ND	ND	ND	ND	ND	ND	ND	ND
Hercules Inc.	281 R	42/MR-14	ND	ND	ND	ND	ND	ND	ND	ND
Hercules Inc. /downstream	280.5 R	43/MR-15	ND	ND	ND	ND	ND	ND	ND	ND
Clarence Cannon NWR	263.5-261.0 R									
Western section		44/MR-19	ND	ND	ND	ND	ND	ND	ND	ND
Southern section		45/MR-20	ND	ND	ND	ND	ND	ND	ND	ND
Eastern section		46/MR-21	ND	ND	ND	ND	ND	ND	ND	ND
Side slough		47/MR-22	ND	ND	ND	ND	ND	ND	ND	ND
Batchtown Division Mark Twain NWR	251.5-246.0									
Upper Pool		48/MR-23			ND	ND				ND
Middle Pool		49/MR-24			ND	ND				ND
Lower Pool		50/MR-25			ND	ND				ND

Table B-3 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	o,p'DDE	p,p'DDE	o,p'DDD	p,p'DDD	o,p'DDT	p,p'DDT
Gardner Division Mark Twain NWR	340-332.5 L							
Side slough/ upstream	on refuge	34/12a	ND	ND	ND	ND	ND	ND
Side slough/ mid sect.	on refuge	35/12b	ND	ND	ND	ND	ND	ND
Side slough/ downstream	on refuge	36/12c	ND	ND	ND	ND	ND	ND
Delair Division Mark Twain NWR	281.5-277.5 L							
N. backwater area	on refuge	39/MR-16	ND	ND	ND	ND	ND	ND
Overflow pond	280.5 L	40/MR-17	ND	ND	ND	ND	ND	ND
Swan Lake	on refuge	41/MR-18	ND	ND	ND	ND	ND	ND
Hercules Inc.	281 R	42/MR-14	ND	ND	ND	ND	ND	ND
Hercules Inc. /downstream	280.5 R	43/MR-15	ND	ND	ND	ND	ND	ND
Clarence Cannon NWR	263.5-261.0 R							
Western section		44/MR-19	ND	ND	ND	ND	ND	ND
Southern section		45/MR-20	ND	ND	ND	ND	ND	ND
Eastern section		46/MR-21	ND	ND	ND	ND	ND	ND
Side slough		47/MR-22	ND	ND	ND	ND	ND	ND
Batchtown Division Mark Twain NWR	251.5-246.0							
Upper Pool		48/MR-23	ND	ND	ND	ND	ND	ND
Middle Pool		49/MR-24	ND	ND	ND	ND	ND	ND
Lower Pool		50/MR-25	ND	ND	ND	ND	ND	ND

Table B-3 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Toxaphene
Gardner Division Mark Twain NWR	340-332.5 L						
Side slough/ upstream	on refuge	34/12a	ND	ND	ND	ND	ND
Side slough/ mid sect.	on refuge	35/12b	ND	ND	ND	ND	ND
Side slough/ downstream	on refuge	36/12c	ND	ND	ND	ND	ND
Delair Division Mark Twain NWR	281.5-277.5 L						
N. backwater area	on refuge	39/MR-16	ND	ND	ND	ND	ND
Overflow pond	280.5 L	40/MR-17	ND	ND	ND	ND	ND
Swan Lake	on refuge	41/MR-18	ND	ND	ND	ND	ND
Hercules Inc.	281 R	42/MR-14	ND	ND	ND	ND	ND
Hercules Inc. /downstream	280.5 R	43/MR-15	ND	ND	ND	ND	ND
Clarence Cannon NWR	263.5-261.0 R						
Western section		44/MR-19	ND	ND	ND	ND	ND
Southern section		45/MR-20	ND	ND	ND	ND	ND
Eastern section		46/MR-21	ND	ND	ND	ND	ND
Side slough		47/MR-22	ND	ND	ND	ND	ND
Batchtown Division Mark Twain NWR	251.5-246.0						
Upper Pool		48/MR-23	ND			ND	ND
Middle Pool		49/MR-24	ND			ND	ND
Lower Pool		50/MR-25	ND			ND	ND

Table B-4. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989, Piasa Harbor/Dresser Island to Osbourne Side Channel.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	HCB	Alpha BHC	Beta BHC	Gamma BHC	Delta BHC	Heptachlor Epoxide
Piasa Harbor/ Dresser Island										
	209.0	51/MR-44	876	43.6	ND	ND	ND	ND	ND	ND
Alton, IL										
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	1000	20.6	ND	ND	ND	ND	ND	ND
Wood River, IL										
Wood River STP	197.9 L	53/MR-27	765	22.4	ND	ND	ND	ND	ND	ND
Shell Oil Co.	197.3 L	54/MR-28	765	27.6	ND	ND	ND	ND	ND	ND
Hartford, IL										
Clark Oil Co.	196.9 L	55/MR-29	847	24.8	ND	ND	ND	ND	ND	ND
Granite City, IL										
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	1100	29.6	ND	ND	ND	ND	ND	ND
East St. Louis, IL										
American Bottoms STP	178.0 L	57/MR-31	810	25.0	ND	ND	ND	ND	ND	ND
St. Louis/ East St. Louis South										
	168.7	58/MR-32	882	45.4	ND	ND	ND	ND	ND	ND
Meramec River										
	160.0	59/MR-33	792	45.4	ND	ND	ND	ND	ND	ND
Herculaneum, MO										
Doe Run Herculaneum	152.0 R	60/MR-34	1380	20.6	ND	ND	ND	ND	ND	ND
Osbourne Side Channel										
	146.5 L	61/MR-35	789	54.8	ND	ND	ND	ND	ND	ND

Table B-4 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Oxy-chlordane	Alpha-chlordane	Gamma chlordane	Cis-Nonachlor	Trans-Nonachlor	Dieldrin	Endrin	Mirex
Piasa Harbor/ Dresser Island	209.0	51/MR-44	ND	ND	ND	ND	ND	ND	ND	ND
Alton, IL										
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	ND	ND	ND	ND	ND	ND	ND	ND
Wood River, IL										
Wood River STP	197.9 L	53/MR-27	ND	ND	ND	ND	ND	ND	ND	ND
Shell Oil Co.	197.3 L	54/MR-28	ND	ND	ND	ND	ND	ND	ND	ND
Hartford, IL										
Clark Oil Co.	196.9 L	55/MR-29	ND	ND	ND	ND	ND	ND	ND	ND
Granite City, IL										
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	ND	ND	ND	ND	ND	ND	ND	ND
East St. Louis, IL										
American Bottoms STP	178.0 L	57/MR-31	ND	ND	ND	ND	ND	ND	ND	ND
St. Louis/ East St. Louis South	168.7	58/MR-32	ND	ND	ND	ND	ND	ND	ND	ND
Meramec River	160.0	59/MR-33	ND	ND	ND	ND	ND	ND	ND	ND
Herculaneum, MO										
Doe Run Herculaneum	152.0 R	60/MR-34	ND	ND	ND	ND	ND	ND	ND	ND
Osbourne Side Channel	146.5 L	61/MR-35	ND	ND	ND	ND	ND	ND	ND	ND

Table B-4 continued. Concentrations (ug/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	o,p'DDE	p,p'DDE	o,p'DDD	p,p'DDD	o,p'DDT	p,p'DDT
Piasa Harbor/ Dresser Island	209.0	51/MR-44	ND	ND	ND	ND	ND	ND
Alton, IL								
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	ND	ND	ND	ND	ND	ND
Wood River, IL								
Wood River STP	197.9 L	53/MR-27	ND	ND	ND	ND	ND	ND
Shell Oil Co.	197.3 L	54/MR-28	ND	ND	ND	ND	ND	ND
Hartford, IL								
Clark Oil Co.	196.9 L	55/MR-29	ND	ND	ND	ND	ND	ND
Granite City, IL								
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	ND	ND	ND	ND	ND	ND
East St. Louis, IL								
American Bottoms STP	178.0 L	57/MR-31	ND	ND	ND	ND	ND	ND
St. Louis/ East St. Louis South	168.7	58/MR-32	ND	ND	ND	ND	ND	ND
Meramec River	160.0	59/MR-33	ND	ND	ND	ND	ND	ND
Herculaneum, MO								
Doe Run Herculaneum	152.0 R	60/MR-34	ND	ND	ND	ND	ND	ND
Osbourne Side Channel	146.5 L	61/MR-35	ND	ND	ND	ND	ND	ND

Table B-4 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Toxaphene
Piasa Harbor/ Dresser Island	209.0	51/MR-44	ND	ND	ND	ND	ND
Alton, IL							
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	ND	ND	ND	ND	ND
Wood River, IL							
Wood River STP	197.9 L	53/MR-27	ND	ND	ND	ND	ND
Shell Oil Co.	197.3 L	54/MR-28	ND	ND	ND	ND	ND
Hartford, IL							
Clark Oil Co.	196.9 L	55/MR-29	ND	ND	ND	ND	ND
Granite City, IL							
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	ND	ND	ND	ND	ND
East St. Louis, IL							
American Bottoms STP	178.0 L	57/MR-31	ND	ND	ND	ND	ND
St. Louis/ East St. Louis South	168.7	58/MR-32	ND	ND	ND	ND	ND
Meramec River	160.0	59/MR-33	ND	ND	ND	ND	ND
Herculaneum, MO							
Doe Run Herculaneum	152.0 R	60/MR-34	ND	ND	ND	ND	ND
Osbourne Side Channel	146.5 L	61/MR-35	ND	ND	ND	ND	ND

Table B-5. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989, Crystal City, MO to Angelo Towhead.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	HCB	Alpha BHC	Beta BHC	Gamma BHC	Delta BHC	Heptachlor Epoxide
Crystal City, MO										
La Rouche Chemical Co.	145.0 R	62/MR-36	848	28.8	ND	ND	ND	ND	ND	ND
Establishment Island (vicinity)	132.0	63/MR-37	988	39.6	ND	ND	ND	ND	ND	ND
St. Genevieve Island (vicinity)	122.0	64/MR-38	846	42.6	ND	ND	ND	ND	ND	ND
Liberty Island (vicinity)	103.0	65/MR-39	912	53.0	ND	ND	ND	ND	ND	ND
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	866	51.0	ND	ND	ND	ND	ND	ND
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	1010	39.2	ND	ND	ND	ND	ND	ND
Thebes, IL										
Ilada Energy	46.5 L	68/MR-41	1010	32.0	ND	ND	ND	ND	ND	ND
Brown's Bar	5.0	69/MR-42	841	57.8	ND	ND	ND	ND	ND	ND
Angelo Towhead	3.0 L	70/MR-45	868	49.6	ND	ND	ND	ND	ND	ND

Table B-5 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Oxy-chlordane	Alpha-chlordane	Gamma chlordane	Cis-Nonachlor	Trans-Nonachlor	Dieldrin	Endrin	Mirex
Crystal City, MO										
La Rouche Chemical Co.	145.0 R	62/MR-36	ND	ND	ND	ND	ND	ND	ND	ND
Establishment Island (vicinity)	132.0	63/MR-37	ND	ND	ND	ND	ND	ND	ND	ND
St. Genevieve Island (vicinity)	122.0	64/MR-38	ND	ND	ND	ND	ND	ND	ND	ND
Liberty Island (vicinity)	103.0	65/MR-39	ND	ND	ND	ND	ND	ND	ND	ND
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	ND	ND	ND	ND	ND	ND	ND	ND
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	ND	ND	ND	ND	ND	ND	ND	ND
Thebes, IL										
Ilada Energy	46.5 L	68/MR-41	ND	ND	ND	ND	ND	ND	ND	ND
Brown's Bar	5.0	69/MR-42	ND	ND	ND	ND	ND	ND	ND	ND
Angelo Towhead	3.0 L	70/MR-45	ND	ND	ND	ND	ND	ND	ND	ND

Table B-5 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	o,p'DDE	p,p'DDE	o,p'DDD	p,p'DDD	o,p'DDT	p,p'DDT
Crystal City, MO								
La Rouche Chemical Co.	145.0 R	62/MR-36	ND	ND	ND	ND	ND	ND
Establishment Island (vicinity)	132.0	63/MR-37	ND	ND	ND	ND	ND	ND
St. Genevieve Island (vicinity)	122.0	64/MR-38	ND	ND	ND	ND	ND	ND
Liberty Island (vicinity)	103.0	65/MR-39	ND	ND	ND	ND	ND	ND
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	ND	ND	ND	ND	ND	ND
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	ND	ND	ND	ND	ND	ND
Thebes, IL								
Ilada Energy	46.5 L	68/MR-41	ND	ND	ND	ND	ND	ND
Brown's Bar	5.0	69/MR-42	ND	ND	ND	ND	ND	ND
Angelo Towhead	3.0 L	70/MR-45	0.07	.18	0.15	0.33	ND	ND

Table B-5 continued. Concentrations (mg/kg dry weight) of organochlorine compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Arochlor 1242	Arochlor 1248	Arochlor 1254	Arochlor 1260	Toxaphene
Crystal City, MO							
La Rouche Chemical Co.	145.0 R	62/MR-36	ND	ND	0.80	0.16	ND
Establishment Island (vicinity)	132.0	63/MR-37	ND	ND	ND	ND	ND
St. Genevieve Island (vicinity)	122.0	64/MR-38	ND	ND	ND	ND	ND
Liberty Island (vicinity)	103.0	65/MR-39	ND	ND	ND	ND	ND
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	ND	ND	ND	ND	ND
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	ND	ND	ND	ND	ND
Thebes, IL							
Ilada Energy	46.5 L	68/MR-41	ND	ND	ND	ND	ND
Brown's Bar	5.0	69/MR-42	ND	ND	ND	ND	ND
Angelo Towhead	3.0 L	70/MR-45	ND	ND		ND	ND

Appendix C

Tables C-1 through C-5

Table C-1. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989, Dubuque, IA to Louisa Division Mark Twain NWR.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	Naptha-lene	Fluo-rene	Phenan-threne	Anthra-cene	Fluoran-threne	Pyrene
Dubuque, IA										
Detention basin	in pond	1/1a	911	18.0	0.01	0.08	0.96	0.20	1.09	0.75
Detention basin	in pond	2/1b	649	29.0	0.09	0.15	0.88	0.23	2.11	1.85
Old Lead Mining Area										
Creek	in creek	3/2a								
Creek	in creek	4/2b							0.02	0.02
Wise Lake (N end)	562.5 L	5/2d	824	52.8	ND	ND	ND	ND	0.03	0.01
Wise Lake (Mid sect.)	561.0 L	6/2e	783	36.2	ND	ND	ND	ND	0.05	0.07
Wise Lake (S end)	560.0 L	7/2f	667	60.6	ND	ND	0.02	ND		
Big Timber Division Mark Twain NWR	446.5-443									
Big Denny Pond	on refuge	13/5a	667	69.4	ND	ND	ND	ND	0.01	0.03
Little Denny Pond	on refuge	14/5b	740	57.8	ND	ND	ND	ND	ND	0.07
Round Pond	on refuge	15/5c	799	60.2	ND	ND	ND	ND	0.02	0.02
Louisa Division Mark Twain NWR	441.5-438 R									
Fox Pond	on refuge	16/6a	517	56.4	ND	ND	ND	ND	ND	0.02
Goose Pond	on refuge	17/6b	726	69.2	ND	ND	ND	ND	ND	0.03
Prairie Pocket	on refuge	18/6c	656	54.2	ND	ND	ND	ND	0.04	0.04
Swarms Pond	on refuge	19/6d	849	63.0	ND	ND	ND	ND	ND	0.02

Table C-1 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	1,2-benzan-thracene	Chrysene	Benzo(b)-fluoranthrene	Benzo(k)-fluoranthrene	Benzo(e)-pyrene	Benzo(a)-pyrene	1,2,5,6-dibenzanthracene
Dubuque, IA									
Detention basin	in pond	1/1a	0.23	0.28	0.28	0.15	0.57	0.53	0.31
Detention basin	in pond	2/1b	0.46	0.77	0.73	0.33	0.61	0.76	0.14
Old Lead Mining Area									
Creek	in creek	3/2a							
Creek	in creek	4/2b							
Wise Lake (N end)	562.5 L	5/2d	ND	ND	0.04	ND	ND	0.02	0.02
Wise Lake (Mid sect.)	561.0 L	6/2e	ND	ND	0.01	ND	ND	0.01	ND
Wise Lake (S end)	560.0 L	7/2f	ND	ND	0.10	0.02	0.02	0.02	ND
Big Timber Division Mark Twain NWR	446.5-443								
Big Denny Pond	on refuge	13/5a	ND	ND	0.03	ND	0.13	0.13	ND
Little Denny Pond	on refuge	14/5b	ND	ND	ND	ND	0.02	ND	ND
Round Pond	on refuge	15/5c	ND	ND	0.07	ND	ND	0.02	ND
Louisa Division Mark Twain NWR	441.5-438 R								
Fox Pond	on refuge	16/6a	ND	0.02	0.02	ND	ND	ND	ND
Goose Pond	on refuge	17/6b	ND	0.03	0.03	ND	ND	ND	ND
Prairie Pocket	on refuge	18/6c	ND	ND	ND	ND	0.02	0.04	ND
Swarms Pond	on refuge	19/6d	ND	ND	0.02	ND	0.02	0.02	ND

Table C-1 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	Benzo(g,h,i) perylene	Oil/Grease
Dubuque, IA				
Detention basin	in pond	1/1a	1.01	5378
Detention basin	in pond	2/1b	.88	4788
Old Lead Mining Area				
Creek	in creek	3/2a		
Creek	in creek	4/2b		
Wise Lake (N end)	562.5 L	5/2d	0.02	466
Wise Lake (Mid sect.)	561.0 L	6/2e	0.01	219
Wise Lake (S end)	560.0 L	7/2f	0.05	812
Big Timber Division Mark Twain NWR	446.5-443			
Big Denny Pond	on refuge	13/5a	0.03	294
Little Denny Pond	on refuge	14/5b	0.02	758
Round Pond	on refuge	15/5c	0.02	653
Louisa Division Mark Twain NWR	441.5-438 R			
Fox Pond	on refuge	16/6a	0.02	1353
Goose Pond	on refuge	17/6b	0.03	1201
Prairie Pocket	on refuge	18/6c	0.02	1790
Swarms Pond	on refuge	19/6d	ND	1000

Table C-2. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989, Keithsburg Division Mark Twain NWR to Alexandria, MO.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	Naptha-lene	Fluo-rene	Phenan-threne	Anthra-cene	Fluoran-threne	Pyrene
Keithsburg Division Mark Twain NWR	431-428 L									
Upstream side slough	on refuge	20/7a	694	56.8	ND	ND	ND	ND	0.02	0.02
Downstream side slough	on refuge	21/7b	556	76.0	ND	ND	ND	ND	ND	ND
Burlington, IA										
General Location	403 R	22/8a	700	60.4	0.02	0.02	0.22	0.02	0.17	0.15
General Location	401 R	23/8b	639	61.8	ND	ND	ND	ND	0.05	0.07
Ft. Madison, IA										
Lead Is. (N end)	387 R	24/9a	800	31.2	ND	ND	ND	0.01	0.05	0.02
General Location	381 R	25/9b								
Devils Creek	378 R	26/9c	696	31.6	ND	ND	ND	ND	0.01	ND
Alexandria, MO	357.0-353.0 R									
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	744	60.6	ND	ND	ND	ND	ND	0.02
Gregory Landing (Fox River)		31/MR-48	673	46.4	ND	ND	ND	ND	ND	ND
Gregory Landing (Willow Lake)		32/MR-49	423	31.0	ND	ND	ND	ND	ND	0.01
Gregory Landing (Nelson Lake)		33/MR-50	765	57.8	ND	ND	ND	ND	ND	ND

Table C-2 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	1,2-benzan-thracene	Chrysene	Benzo(b)-fluoranthrene	Benzo(k)-fluoranthrene	Benzo(e)-pyrene	Benzo(a)-pyrene	1,2,5,6-dibenzanthracene
Keithsburg Division Mark Twain NWR	431-428 L								
Upstream side slough	on refuge	20/7a	ND	0.02	0.02	ND	0.02	0.02	ND
Downstream side slough	on refuge	21/7b	ND	ND	0.08	ND	ND	ND	ND
Burlington, IA									
General Location	403 R	22/8a	0.05	0.07	0.05	0.02	0.02	0.02	0.02
General Location	401 R	23/8b	ND	0.02	0.02	ND	0.02	0.02	ND
Ft. Madison, IA									
Lead Is. (N end)	387 R	24/9a	0.02	0.02	0.02	0.01	0.01	0.02	0.01
General Location	381 R	25/9b							
Devils Creek	378 R	26/9c	ND	ND	0.01	ND	ND	0.02	ND
Alexandria, MO	357.0-353.0 R								
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	ND	ND	0.05	ND	0.02	ND	ND
Gregory Landing (Fox River)		31/MR-48	ND	ND	0.03	ND	ND	ND	0.01
Gregory Landing (Willow Lake)		32/MR-49	ND	ND	0.02	ND	ND	ND	ND
Gregory Landing (Nelson Lake)		33/MR-50	ND	ND	0.02	ND	ND	ND	ND

Table C-2 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	Benzo(g,h,i) perylene	Oil/Grease
Keithsburg Division Mark Twain NWR	431-428 L			
Upstream side slough	on refuge	20/7a	0.04	740
Downstream side slough	on refuge	21/7b	ND	999
Burlington, IA				
General Location	403 R	22/8a	0.02	136
General Location	401 R	23/8b	0.02	628
Ft. Madison, IA				
Lead Is. (N end)	387 R	24/9a	0.02	130
General Location	381 R	25/9b		
Devils Creek	378 R	26/9c	0.01	263
Alexandria, MO	357.0-353.0 R			
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	0.02	1065
Gregory Landing (Fox River)		31/MR-48	0.03	298
Gregory Landing (Willow Lake)		32/MR-49	ND	ND
Gregory Landing (Nelson Lake)		33/MR-50	ND	ND

Table C-3. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989, Gardner Division Mark Twain NWR to Batchtown Division Mark Twain NWR.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	Naptha-lene	Fluo-rene	Phenan-threne	Anthra-cene	Fluoran-threne	Pyrene
Gardner Division Mark Twain NWR	340-332.5 L									
Side slough/ upstream	on refuge	34/12a	802	49.8	ND	ND	ND	ND	0.01	0.01
Side slough/ mid sect.	on refuge	35/12b	760	33.4	ND	ND	ND	ND	ND	ND
Side slough/ downstream	on refuge	36/12c	672	31.6	ND	ND	ND	ND	0.02	0.01
Delair Division Mark Twain NWR	281.5-277.5 L									
N. backwater area	on refuge	39/MR-16	766	49.8	ND	ND	0.01	ND	0.03	0.03
Overflow pond	280.5 L	40/MR-17	879	43.4	ND	ND	ND	ND	ND	ND
Swan Lake	on refuge	41/MR-18	718	41.4	ND	ND	ND	ND	ND	0.01
Hercules Inc.	281 R	42/MR-14	826	49.6	ND	ND	0.01	ND	0.01	0.01
Hercules Inc. /downstream	280.5 R	43/MR-15	915	28.0	ND	ND	0.01	ND	0.02	0.01
Clarence Cannon NWR	263.5-261.0 R									
Western section		44/MR-19	813	44.4	ND	ND	ND	ND	ND	ND
Southern section		45/MR-20	752	63.6	ND	ND	ND	ND	ND	ND
Eastern section		46/MR-21	781	47.4	ND	ND	ND	ND	ND	ND
Side slough		47/MR-22	843	50.8	ND	ND	ND	ND	ND	ND
Batchtown Division Mark Twain NWR	251.5-246.0									
Upper Pool		48/MR-23		57.6			ND		ND	ND
Middle Pool		49/MR-24		59.0			ND		ND	ND
Lower Pool		50/MR-25		59.4			ND		ND	ND

Table C-3 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	1,2-benzan-thracene	Chrysene	Benzo(b)-fluoranthrene	Benzo(k)-fluoranthrene	Benzo(e)-pyrene	Benzo(a)-pyrene	1,2,5,6-dibenzanthracene
Gardner Division Mark Twain NWR	340-332.5 L								
Side slough/ upstream	on refuge	34/12a	ND	ND	0.01	ND	0.01	0.01	ND
Side slough/ mid sect.	on refuge	35/12b	ND	ND	ND	ND	0.01	ND	ND
Side slough/ downstream	on refuge	36/12c	ND	ND	0.01	ND	0.01	0.01	0.02
Delair Division Mark Twain NWR	281.5-277.5 L								
N. backwater area	on refuge	39/MR-16	ND	0.01	0.01	ND	0.01	0.01	0.01
Overflow pond	280.5 L	40/MR-17	ND	ND	ND	ND	0.01	ND	ND
Swan Lake	on refuge	41/MR-18	ND	ND	ND	ND	ND	ND	ND
Hercules Inc.	281 R	42/MR-14	ND	ND	0.01	ND	ND	ND	ND
Hercules Inc. /downstream	280.5 R	43/MR-15	ND	ND	ND	ND	ND	0.01	ND
Clarence Cannon NWR	263.5-261.0 R								
Western section		45/MR-20	ND	ND	ND	ND	ND	ND	ND
Eastern section		46/MR-21	ND	ND	ND	ND	ND	ND	ND
Side slough		47/MR-22	ND	ND	0.02	ND	ND	ND	ND
Batchtown Division Mark Twain NWR	251.5-246.0								
Upper Pool		48/MR-23	ND	ND	0.09	ND	ND	ND	ND
Middle Pool		49/MR-24	ND	ND	0.09	ND	ND	ND	ND
Lower Pool		50/MR-25	ND	ND	0.04	ND	ND	ND	ND

Table C-3 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	Benzo(g,h,i) perylene	Oil/Grease
Gardner Division Mark Twain NWR	340-332.5 L			
Side slough/ upstream	on refuge	34/12a	ND	577
Side slough/ mid sect.	on refuge	35/12b	ND	135
Side slough/ downstream	on refuge	36/12c	0.04	438
Delair Division Mark Twain NWR	281.5-277.5 L			
N. backwater area	on refuge	39/MR-16	0.03	398
Overflow pond	280.5 L	40/MR-17	ND	388
Swan Lake	on refuge	41/MR-18	ND	358
Hercules Inc.	281 R	42/MR-14	ND	694
Hercules Inc. /downstream	280.5 R	43/MR-15	0.01	208
Clarence Cannon NWR	263.5-261.0 R			
Western section		44/MR-19	ND	503
Southern section		45/MR-20	ND	439
Eastern section		46/MR-21	ND	779
Side slough		47/MR-22	ND	691
Batchtown Division Mark Twain NWR	251.5-246.0			
Upper Pool		48/MR-23	0.02	ND
Middle Pool		49/MR-24	0.02	219
Lower Pool		50/MR-25	ND	ND

Table C-4. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989, Piasa Harbor/Dresser Island to Osbourne Side Channel.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	Naptha-lene	Fluo-rene	Phenan-threne	Anthra-cene	Fluoran-threne	Pyrene
Piasa Harbor/ Dresser Island	209.0	51/MR-44	876	43.6	0.01	0.21	0.05	0.17	0.17	0.21
Alton, IL										
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	1000	20.6	ND	0.01	0.18	0.05	0.15	0.10
Wood River, IL										
Wood River STP	197.9 L	53/MR-27	765	22.4	0.01	0.02	0.15	0.02	0.19	0.12
Shell Oil Co.	197.3 L	54/MR-28	765	27.6	0.01	0.02	0.11	ND	0.02	0.12
Hartford, IL										
Clark Oil Co.	196.9 L	55/MR-29	847	24.8	0.03	0.03	0.39	0.07	0.40	0.35
Granite City, IL										
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	1100	29.6	0.39	0.80	2.6	0.52	2.6	1.8
East St. Louis, IL										
American Bottoms STP	178.0 L	57/MR-31	810	25.0	ND	ND	0.06	0.01	0.02	0.02
St. Louis/ East St. Louis South	168.7	58/MR-32	882	45.4	0.01	0.01	0.21	0.03	0.31	0.20
Meramec River	160.0	59/MR-33	792	45.4	ND	ND	0.03	ND	0.05	0.03
Herculaneum, MO										
Doe Run Herculaneum	152.0 R	60/MR-34	1380	20.6	ND	0.02	0.11	ND	0.07	0.06
Osbourne Side Channel	146.5 L	61/MR-35	789	54.8	.02	0.02	0.08	0.08	0.13	0.08

Table C-4 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	1,2-benzan-threcene	Chrysene	Benzo(b)-fluoranthrene	Benzo(k)-fluoranthrene	Benzo(e)-pyrene	Benzo(a)-pyrene	1,2,5,6-dibenzanthracene
Piasa Harbor/ Dresser Island	209.0	51/MR-44	0.05	0.10	0.03	0.01	0.01	0.07	0.01
Alton, IL									
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	0.08	0.07	0.05	0.01	0.10	0.05	0.01
Wood River, IL									
Wood River STP	197.9 L	53/MR-27	0.07	0.09	0.07	0.02	0.06	0.09	0.07
Shell Oil Co.	197.3 L	54/MR-28	0.02	0.03	0.02	0.01	0.11	0.04	0.05
Hartford, IL									
Clark Oil Co.	196.9 L	55/MR-29	0.11	0.06	0.15	0.09	0.17	0.07	0.19
Granite City, IL									
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	0.93	.2	0.51	0.21	0.80	0.59	0.09
East St. Louis, IL									
American Bottoms STP	178.0 L	57/MR-31	ND	0.01	0.01	ND	0.01	0.01	ND
St. Louis/ East St. Louis South	168.75	57/MR-32	0.07	0.10	0.10	0.01	0.21	0.10	0.01
Meramec River	160.0	59/MR-33	ND	ND	0.01	ND	0.01	0.01	ND
Herculaneum, MO									
Doe Run Herculaneum	152.0 R	60/MR-34	ND	0.01	0.01	ND	ND	ND	ND
Osbourne Side Channel	146.5 L	61/MR-35	0.02	0.04	.04	0.02	0.04	0.04	0.02

Table C-4 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Benzo(g,h,i) perylene	Oil/Grease
Piasa Harbor/ Dresser Island	209.0	51/MR-44	0.03	ND
Alton, IL				
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	0.05	ND
Wood River, IL				
Wood River STP	197.9 L	53/MR-27	0.06	270
Shell Oil Co.	197.3 L	54/MR-28	0.01	2707
Hartford, IL				
Clark Oil Co.	196.9 L	55/MR-29	0.09	1569
Granite City, IL				
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	0.51	4815
East St. Louis, IL				
American Bottoms STP	178.0 L	57/MR-31	0.01	ND
St. Louis/ East St. Louis South	168.7	58/MR-32	0.09	860
Meramec River	160.0	59/MR-33	0.01	109
Herculaneum, MO				
Doe Run Herculaneum	152.0 R	60/MR-34	ND	125
Osbourne Side Channel	146.5 L	61/MR-35	0.04	199

Table C-5. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989, Crystal City, MO to Angelo Towhead.

Sample Location	River Mile(s)	Sample Number	Sample Wt.	%Moisture	Naptha-lene	Fluo-rene	Phenan-threne	Anthra-cene	Fluoran-threne	Pyrene
Crystal City, MO										
La Rouche Chemical Co.	145.0 R	62/MR-36	848	28.8	ND	ND	0.04	0.01	0.07	0.05
Establishment Island (vicinity)	132.0	63/MR-37	988	39.6	ND	0.01	0.06	ND	0.11	0.06
St. Genevieve Island (vicinity)	122.0	64/MR-38	846	42.6	ND	0.03	0.15	0.01	0.06	0.06
Liberty Island (vicinity)	103.0	65/MR-39	912	53.0	ND	ND	0.04	ND	0.08	0.06
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	866	51.0	ND	ND	0.04	ND	0.08	0.08
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	1010	39.2	ND	ND	0.04	ND	0.06	0.08
Thebes, IL										
Ilada Energy	46.5 L	68/MR-41	1010	32.0	ND	ND	0.02	ND	0.05	0.05
Brown's Bar	5.0	69/MR-42	841	57.8	ND	ND	0.04	ND	0.09	0.09
Angelo Towhead	3.0 L	70/MR-45	868	49.6	ND	ND	0.03	ND	0.09	0.07

Table C-5 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	1,2-benzan-thracene	Chrysene	Benzo(b)-fluoranthrene	Benzo(k)-fluoranthrene	Benzo(e)-pyrene	Benzo(a)-pyrene	1,2,5,6-dibenzanthracene
Crystal City, MO									
La Rouche Chemical Co.	145.0 R	62/MR-36	0.02	0.04	0.01	0.01	0.01	0.01	0.01
Establishment Island (vicinity)	132.0	63/MR-37	0.03	0.04	0.03	ND	0.06	0.01	0.04
St. Genevieve Island (vicinity)	122.0	64/MR-38	0.01	0.03	0.03	0.01	0.01	0.01	0.05
Liberty Island (vicinity)	103.0	65/MR-39	0.02	0.04	0.02	0.02	0.02	0.04	0.04
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	0.04	0.04	0.02	ND	0.04	0.02	0.06
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	0.01	0.03	0.01	0.01	0.03	0.03	0.06
Thebes, IL									
Ilada Energy	46.5 L	68/MR-41	0.02	0.02	0.02	0.01	0.02	0.02	0.04
Brown's Bar	5.0	69/MR-42	0.02	0.04	0.02	0.02	0.11	0.02	0.07
Angelo Towhead	.0 L	70/MR-45	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Table C-5 continued. Concentrations (mg/kg dry weight) of polycyclic aromatic hydrocarbon (PAH's) compounds detected in sediments collected from the Mississippi River in 1989.

Sample Location	River Miles(s)	Sample Number	Benzo(g,h,i) perylene	Oil/Grease
Crystal City, MO				
La Rouche Chemical Co.	145.0 R	62/MR-36	0.02	126
Establishment Island (vicinity)	132.0	63/MR-37	0.03	314
St. Genevieve Island (vicinity)	122.0	64/MR-38	0.01	452
Liberty Island (vicinity)	103.0	65/MR-39	0.02	ND
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	0.02	204
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	0.01	ND
Thebes, IL				
Ilada Energy	46.5 L	68/MR-41	0.02	161
Brown's Bar	.0	69/MR-42	0.02	118
Angelo Towhead	.0 L	70/MR-45	0.01	297

Appendix D

Table D-1. 1989 Mississippi River solid phase sediment and water 96-hour fathead minnow bioassay results (total mortality at 96-hours of exposure).

Sample Location	River Mile(s)	Sample Number	Fathead minnow mortality (number dead/number tested): Control	Sample
Dubuque, IA				
Detention basin	in pond	1/1a	0/20	10/20
Detention basin	in pond	2/1b	0/21	20/20
Old Lead Mining Area				
Creek	in creek	3/2a	0/20	0/20
Creek	in creek	4/2b	0/20	0/20
Wise Lake (N end)	562.5 L	5/2d	0/20	4/20
Wise Lake (Mid sect.)	561.0 L	6/2e	0/20	6/20
Wise Lake (S end)	560.0 L	7/2f	0/20	18/20
Bettendorf, IA				
ALCOA	489 R	8/3a	0/21	0/20
ALCOA/downstream	488 R	9/3b	0/21	3/20
Muscatine, IA				
Monsanto Corp.	449.9 R	10/4a	1/20	1/20
Monsanto/upstream	450.3 R	11/4b	0/21	1/20
Monsanto/downstream	449.3 R	12/4c	0/21	1/20
Big Timber Division Mark Twain NWR	446.5-443			
Big Denny Pond	on refuge	13/5a	0/20	0/20
Little Denny Pond	on refuge	14/5b	0/20	1/20
Round Pond	on refuge	15/5c	2/20	0/20
Louisa Division Mark Twain NWR	441.5-438 R			
Fox Pond	on refuge	16/6a	0/20	0/20
Goose Pond	on refuge	17/6b	0/21	1/20
Prairie Pocket	on refuge	18/6c	0/20	0/20
Swarms Pond	on refuge	19/6d	2/20	4/20
Keithsburg Division Mark Twain NWR	431-428 L			
Upstream side slough	on refuge	20/7a	0/20	4/20
Downstream side slough	on refuge	21/7b	0/20	1/20
Burlington, IA				
General Location	403 R	22/8a	0/21	20/20
General Location	401 R	23/8b	0/21	13/21
Ft. Madison, IA				
Lead Is. (N end)	387 R	24/9a	0/20	6/20
General Location	381 R	25/9b	0/20	4/20
Devils Creek	378 R	26/9c	0/20	6/20

Table D-1 continued. 1989 Mississippi River solid phase sediment and water 96-hour fathead minnow bioassay results (total mortality at 96-hours of exposure).

Sample Location	River Mile(s)	Sample Number	Fathead minnow mortality (number dead/number tested): Control	Sample
George Arthur Refuge (IDOC)				
General location	374.5	27/10a	0/21	0/20
Keokuk, IA				
General Location	365 R	28/11a	0/21	0/20
General Location	363 R	29/11b	2/20	1/20
Alexandria, MO	357.0-353.0 R			
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	1/21	18/21
Gregory Landing (Fox River)		31/MR-48	1/21	2/21
Gregory Landing (Willow Lake)		32/MR-49	1/21	1/20
Gregory Landing (Nelson Lake)		33/MR-50	1/21	1/20
Gardner Division Mark Twain NWR	340-332.5 L			
Side slough/ upstream	on refuge	34/12a	2/20	13/20
Side slough/ mid sect.	on refuge	35/12b	0/20	3/20
Side slough/ downstream	on refuge	36/12c	2/20	2/20
Hannibal, MO				
American Cyanamid Co. /downstream	319.7 R	37/13a	2/20	2/20
Bay de Charles (where ditch enters bay)	in bay	38/13b	2/20	1/20
Delair Division Mark Twain NWR	281.5-277.5 L			
N. backwater area	on refuge	39/MR-16	0/20	2/20
Overflow pond	280.5 L	40/MR-17	1/21	1/20
Swan Lake	on refuge	41/MR-18	1/21	0/20
Hercules Inc.	281 R	42/MR-14	1/21	0/20
Hercules Inc. /downstream	280.5 R	43/MR-15	0/20	0/20
Clarence Cannon NWR	263.5-261.0 R			
Western section		44/MR-19	0/20	1/20
Southern section		45/MR-20	1/21	0/21
Eastern section		46/MR-21	0/20	0/21
Side slough		47/MR-22	0/20	0/20

Table D-1 continued. 1989 Mississippi River solid phase sediment and water 96-hour fathead minnow bioassay results (total mortality at 96-hours of exposure).

Sample Location	River Mile(s)	Sample Number	Fathead minnow mortality (number dead/number tested): Control	Sample
Batchtown Division Mark Twain NWR	251.5-246.0			
Upper Pool		48/MR-23	1/21	1/20
Middle Pool		49/MR-24	1/21	1/20
Lower Pool		50/MR-25	0/20	1/20
Piasa Harbor/ Dresser Island	209.0	51/MR-44	0/20	1/21
Alton, IL				
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	0/20	1/20
Wood River, IL				
Wood River STP	197.9 L	53/MR-27	0/20	1/20
Shell Oil Co.	197.3 L	54/MR-28	0/20	0/19
Hartford, IL				
Clark Oil Co.	196.9 L	55/MR-29	0/20	0/21
Granite City, IL				
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	0/20	1/20
East St. Louis, IL				
American Bottoms STP	178.0 L	57/MR-31	0/20	20/20
St. Louis/ East St. Louis South	168.7	58/MR-32	0/20	10/20
Meramec River	160.0	59/MR-33	0/20	0/21
Herculaneum, MO				
Doe Run Herculaneum	152.0 R	60/MR-34	0/20	0/20
Osbourne Side Channel	146.5 L	61/MR-35	0/20	0/20
Crystal City, MO				
La Rouche Chemical Co.	145.0 R	62/MR-36	0/20	1/20
Establishment Island (vicinity)	132.0	63/MR-37	0/20	0/20
St. Genevieve Island (vicinity)	122.0	64/MR-38	0/20	0/20
Liberty Island (vicinity)	103.0	65/MR-39	1/21	2/20

Table D-1 continued. 1989 Mississippi River solid phase sediment and water 96-hour fathead minnow bioassay results (total mortality at 96-hours of exposure).

Sample Location	River Mile(s)	Sample Number	Fathead minnow mortality (number dead/number tested): Control	Sample
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	0/20	0/20
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	1/21	1/20
Thebes, IL				
Ilada Energy	46.5 L	68/MR-41	0/20	0/20
Brown's Bar	25.0	69/MR-42	0/20	1/20
Angelo Towhead	3.0 L	70/MR-45	0/20	0/20

Appendix E

Table E-1. Water chemistry data - solid phase sediment and water 96-hour fathead minnow bioassays of sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Temp (deg.C°)	pH	DO	NH_3-N (mg/L)	Total NH_3 (mg/L)	Unionized NH_3 (mg/L)	Total Hardness (mg/L $CaCO_3$)	Specific Conductance (mmhos)
Dubuque, IA										
Detention basin	in pond	1/1a	21	7.6	5.9	6.8	8.3	0.1	255	510
Detention basin	in pond	2/1b	21	7.5	5.6	16	19.4	0.26	125	200
Old Lead Mining Area										
Creek	in creek	3/2a	21	7.6	4.8	3.1	3.8	0.06	375	380
Creek	in creek	4/2b	21	7.6	7.4	3.2	3.9	0.07	330	340
Wise Lake (N end)	562.5 L	5/2d-1	21	7.7	7.9	2.4	2.9	0.06	280	390
		5/2d-2	21	7.7	7.6	2.1	2.6	0.05	300	370
Wise Lake (Mid sect.)	561.0 L	6/2e	21	7.8	8.1	2.2	2.7	0.07	275	360
Wise Lake (S end)	560.0 L	7/2f	21	7.6	7.8	7.5	9.1	0.02	215	350
Bettendorf, IA										
ALCOA	489 R	8/3a	21	7.3	6.7	3.8	4.6	0.03	300	530
ALCOA/downstream	488 R	9/3b	21	7.5	6.6	5.0	6.1	0.06	210	500
Muscatine, IA										
Monsanto Corp.	449.9 R	10/4a	24	8.0	4.9	2.4	2.9	0.12	180	420
Monsanto/upstream	450.3 R	11/4b	21	7.3	6.8	2.8	3.4	0.02	230	470
Monsanto/downstream	449.3 R	12/4c	21	7.0	6.6	4.8	5.8	0.02	270	600
Big Timber Division Mark Twain NWR	446.5-443									
Big Denny Pond	on refuge	13/5a	24	7.9	8.1	2.3	2.8	0.11	370	740
		13/5a	24	8.0	8.1	1.8	2.2	0.11	360	740
Little Denny Pond	on refuge	14/5b	24	7.1	8.2	1.6	1.9	0.01	170	390
Round Pond	on refuge	15/5c	24	7.7	8.1	3.9	4.7	0.12	220	380
Louisa Division Mark Twain NWR	441.5-438 R									
Fox Pond	on refuge	16/6a	23	7.2	7.4	2.4	2.9	0.02	170	320
Goose Pond	on refuge	17/6b	22	7.7	8.2	7.6	9.2	0.21	230	420
Prairie Pocket	on refuge	18/6c	21	7.3	7.2	2.9	3.5	0.03	180	300
Swarms Pond	on refuge	19/6d	24	7.6	8.2	4.9	6.0	0.12	235	370

Table E-1 continued. Water chemistry data - solid phase sediment and water 96-hour fathead minnow bioassays of sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Temp (deg.C°)	pH	DO	NH_3-N (mg/L)	Total NH_3 (mg/L)	Unionized NH_3 (mg/L)	Total Hardness (mg/L $CaCO_3$)	Specific Conductance (mmhos)
Keithsburg Division Mark Twain NWR	431-428 L									
Upstream side slough	on refuge	20/7a	24	7.7	8.1	3.6	4.4	0.11	160	360
Downstream side slough	on refuge	21/7b	21	7.3	7.3	5.6	6.8	0.06	240	400
Burlington, IA										
General Location	403 R	22/8a	21	7.0	6.1	22	26.7	1.1	200	789
General Location	401 R	23/8b-1	21	7.3	6.9	10	12.2	0.08	150	370
		8b-2	21	7.3	6.6	11	13.4	0.09	190	470
Ft. Madison, IA										
Lead Is. (N end)	387 R	24/9a	21	7.6	7.75	2.9	3.5	0.06	230	310
General Location	381 R	25/9b	21	7.5	7.1	3.8	4.6	0.06	190	320
Devils Creek	378 R	26/9c	21	7.6	7.35	4.2	5.1	0.09	190	290
George Arthur Refuge (IDOC)										
General location	374.5	27/10a	21	7.4	7.2	2.7	3.3	0.03	140	370
Keokuk, IA										
General Location	365 R	28/11a	21	7.7	7.1	1.8	2.2	0.05	150	290
General Location	363 R	29/11b	24	7.9	8.2	2.7	3.3	0.13	255	360
Alexandria, MO	357.0-353.0 R									
Gregory Landing (Grey Chute)	357.0 R	30/MR-47	22	7.4	7.6	16	9.4	0.22	200	365
Gregory Landing (Fox River)		31/MR-48	22	7.5	7.7	3.2	3.9	0.06	225	310
Gregory Landing (Willow Lake)		32/MR-49	22	7.0	7.8	0.3	0.36	0.002	150	320
Gregory Landing (Nelson Lake)		33/MR-50	22	7.3	.8	1.2	.5	0.01	250	480

Table E-1 continued. Water chemistry data - solid phase sediment and water 96-hour fathead minnow bioassays of sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Temp (deg.C°)	pH	DO	NH_3-N (mg/L)	Total NH_3 (mg/L)	Unionized NH_3 (mg/L)	Total Hardness (mg/L $CaCO_3$)	Specific Conductance (umhos)
Gardner Division Mark Twain NWR	340-332.5 L									
Side slough/ upstream	on refuge	34/12a	24	7.5	7.8	6.8	8.3	0.14	270	460
Side slough/ mid sect.	on refuge	35/12b	24	7.4	8.0	4.5	5.5	0.07	150	350
Side slough/ downstream	on refuge	36/12c	24	7.5	7.5	6.1	7.4	0.12	250	400
Hannibal, MO										
American Cyanamid Co. /downstream	319.7 R	37/13a	24	7.7	8.0	3.8	4.6	0.12	185	310
Bay de Charles (where ditch enters bay)	in bay	38/13b	24	7.6	7.4	3.0	3.6	0.07	210	370
Delair Division Mark Twain NWR	281.5-277.5 L									
N. backwater area	on refuge	39/MR-16	22	7.3	7.4	9.5	1.5	0.10	210	380
Overflow pond	280.5 L	40/MR-17	22	7.4	7.7	2.2	2.7	0.03	165	310
Swan Lake	on refuge	41/MR-18	22	7.4	7.8	1.4	1.7	0.02	160	290
Hercules Inc.	281 R	42/MR-14	22	7.3	7.7	9.4	1.4	0.10	190	330
Hercules Inc. /downstream	280.5 R	43/MR-15	21	7.4	7.6	3.6	4.4	0.05	200	400
Clarence Cannon NWR	263.5-261.0 R									
Western section		44/MR-19	22	7.6	7.5	0.9	1.1	0.02	215	380
Southern section		45/MR-20	22	7.5	7.7	2.3	2.8	0.04	180	270
Eastern section		46/MR-21	22	7.2	7.5	1.4	1.7	0.01	128	190
Side slough		47/MR-22	21	7.1	7.8	1.8	2.2	0.01	150	260
Batchtown Division Mark Twain NWR	251.5-246.0									
Upper Pool		48/MR-23	22	7.6		4.2	5.1	0.09		
Middle Pool		49/MR-24	22	7.8		3.5	4.3	0.12		
Lower Pool		50/MR-25	21	7.5		4.3	5.2	0.07		

Table E-1 continued. Water chemistry data - solid phase sediment and water 96-hour fathead minnow bioassays of sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Temp (deg.C°)	pH	DO	NH_3-N (mg/L)	Total NH_3 (mg/L)	Unionized NH_3 (mg/L)	Total Hardness (mg/L $CaCO_3$)	Specific Conductance (mmhos)
Piasa Harbor/ Dresser Island	209.0	51/MR-44	22	7.5	7.9	7.3	8.9	0.13	110	320
		MR-44	22	7.4	7.9	7.1	8.6	0.10	125	340
Alton, IL										
Jefferson Smurfit, Inc.	201.4 L	52/MR-26	23	7.9	7.6	1.2	1.5	0.06	200	400
Wood River, IL										
Wood River STP	197.9 L	53/MR-27	23	7.6	7.6	2.5	3.0	0.06	165	360
Shell Oil Co.	197.3 L	54/MR-28	23	7.7	7.9	3.3	4.0	0.10	165	400
Hartford, IL										
Clark Oil Co.	196.9 L	55/MR-29	23	7.8	7.8	2.1	2.6	0.08	200	400
Granite City, IL										
Granite City STP/ Chain-of-Rocks Canal		56/MR-30	23	7.7	7.8	3.2	3.9	0.09	190	410
East St. Louis, IL										
American Bottoms STP	178.0 L	57/MR-31	23	7.6	7.7	15	18.2	0.44	160	550
St. Louis/ East St. Louis South	168.7	58/MR-32	22	7.6	7.8	13	15.8	0.28	250	550
Meramec River	160.0	59/MR-33	22	7.6	7.8	3.0	3.6	0.06	180	340
Herculaneum, MO										
Doe Run Herculaneum	152.0 R	60/MR-34	23	8.4	7.7	0.1	0.12	0.01	200	450
		MR-34	23	8.4	7.8	0.2	0.24	0.03	250	450
Osbourne Side Channel	146.5 L	61/MR-35	22	7.6	7.9	5.2	6.3	0.11	235	480

Table E-1 continued. Water chemistry data solid phase sediment and water 96-hour fathead minnow bioassays of sediments collected from the Mississippi River in 1989.

Sample Location	River Mile(s)	Sample Number	Temp (deg.C°)	pH	DO	NH_3-N (mg/L)	Total NH_3 (mg/L)	Unionized NH_3 (mg/L)	Total Hardness (mg/L $CaCO_3$)	Specific Conductance (umhos)
Crystal City, MO										
La Rouche Chemical Co.	145.0 R	62/MR-36	23	8.0	7.7	5.2	6.3	0.30	195	430
Establishment Island (vicinity)	132.0	63/MR-37	22	7.6	7.8	6.5	7.9	0.14	200	440
St. Genevieve Island (vicinity)	122.0	64/MR-38	22	7.7	7.8	3.6	4.4	0.10	175	420
Liberty Island (vicinity)	103.0	65/MR-39	22	7.6	8.0	5.6	6.8	0.12	165	420
Big Muddy/ Grand Tower Island (vicinity)	72.0 L	66/MR-43	22	7.6	7.8	4.6	5.6	0.10	220	480
Cape Girardeau, MO (vicinity)	49.5 R	67/MR-40	22	7.7	7.8	4.8	5.8	0.13	230	400
Thebes, IL										
Ilada Energy	46.5 L	68/MR-41	23	7.9	7.6	0.9		0.04	210	370
Brown's Bar	5.0	69/MR-42	22	7.7	7.8	4.6	5.7	0.13	90	490
Angelo Towhead	3.0 L	70/MR-45	22	7.6	8.1	6.4	7.8	0.14	25	390